ORIGINS

• Journal of the Biblical Creation Society •

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In this issue:

Seeing and Believing 3

The Changing Views of Professor Arthur Rendle-Short

The Decay in the Velocity of Light

Haemoglobin

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Editorial

IN THE BEGINNING was the Word, and the Word was with God, and the Word was God. He was with God in the beginning. Through him all things were made; without him nothing was made that has been made (John 1:1–3, NIV)**. Thus begins John's Gospel, cementing together the New and Old Testaments within the only sure foundation for the Good News of the Kingdom of God. Christ as Creator is also to be found in 1 Corinthians 8:6, Colossians 1:16, and Hebrews 1:2.**

Back in *Origins* 3:7 we indicated that over several issues we would try and review some of the evidence relevant to the vexed question of the age of the Earth. What follows are questions and personal opinions, and not a statement of the Biblical Creation Society's position. My motive is to stimulate the membership to consider these matters. Let us try to resolve whether, within the spectrum of beliefs of those regarding themselves as Creationists, it is right to insist that it is essential that Creation was completed in six literal days, and the entire history of the world is embraced within the genealogies given in scripture. Are these matters important enough to divide us, when there is so much common ground? In contrast other societies at home and world-wide consider that these ARE essentials of faith. They consider that if we are to be consistent in the way we handle the whole of scripture, we cannot equivocate on these matters.

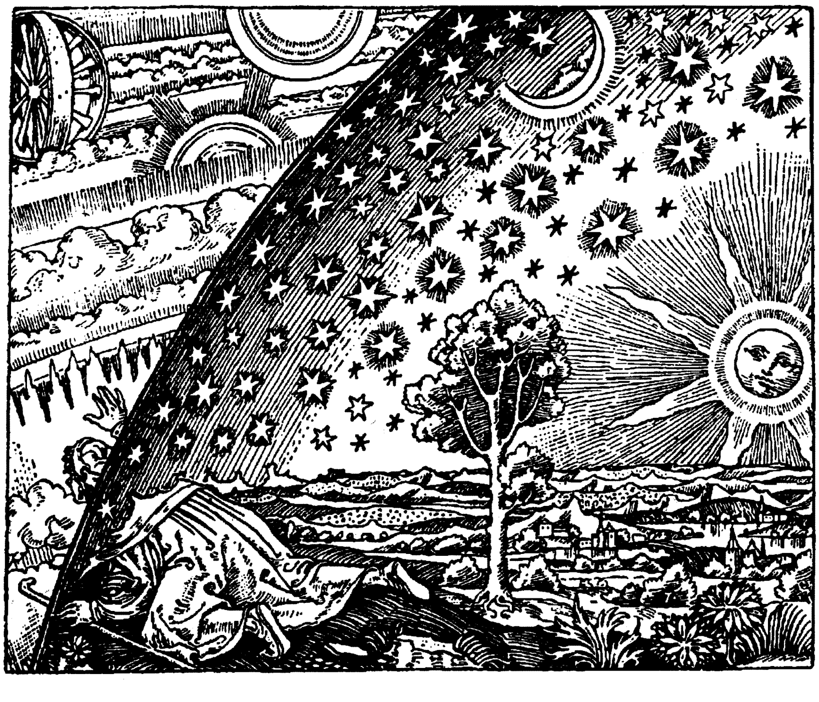
A dividing line between theistic evolutionists and creationists is the special creation of Adam, distinct from any supposed ancestral primate, and in some state of perfection from which he could Fall. It was in fact this last consideration that changed Arthur Rendle-Short's thinking, as can be seen within this issue of *Origins.*

Within the bounds of creationism there is a divide between those that believe that only humans did not die before the Fall, and those that consider that no creature with a 'nephesh' or soul, died until the time of the Curse. Thus it is said that God originally designed a vegetarian world, and soulless plants were given for food. Difficulties with this latter position must be tackled by considering the matter of the lack of 'accidents' in a perfect world. In trusting God we must be content to say that this is outside of human experience. The spectrum of belief may be followed through to a position of a straightforward reading of Genesis. The universe was created in six days, and the genealogies tell us how long ago, with very little margin for error.

Let us consider the following. Those who depend upon the unique sacrifice of Christ for their salvation are disdainful of those who would attempt to explain away his miracles in naturalistic terms. As a typical example, it is said by sceptics that ever-changing currents in the Sea of Galilee throw up temporary sand-bars. In appearing to walk on the water Christ merely walked along such a formation, just below the water's surface. To one who worships their Saviour as truly divine this is not tenable.

Now John tells us that there was nothing made in the beginning that was not made by Christ. We accept his first miracle in the New Testament when he turned water into wine, at the wedding at Cana. Why do we still try to explain away his first miracles in the Old Testament, throughout Creation Week?

The typical problems come from regarding that which has been commonplace throughout history, as that which is Absolute. So there seems to be a problem with the first occurrences of 'evening and morning', given that the sun, moon and stars were not created until Day 4. The solution lies in the fact that God is the creator and sustainer of both time and light. The sun, moon and stars are secondary sources, akin to candles and shadow-clocks. God chose not to provide 'artificial' light and time-pieces until the fourth day. Indeed, as it was, so shall it be. Revelation tells



of the city of God. The city does not need the sun or the moon to shine on it, for the glory of God gives it light, and the Lamb is its lamp (Revelation 21:23).

In the matter of the apparent great age of the Earth making us question the genealogies, we have indeed been like 'Doubting Thomas', demanding to see the scars that prove that a miracle has occurred. Mercifully, our Lord gave us the eruption of Mount St. Helens in 1980. This catastrophe rapidly produced a number of geological phenomena that were previously only ever described in slow uniformitarian terms (see *'Lessons from Mt. St. Helens'*, video review, *Origins* 3:8 p.14), and therefore a severe test of our faith. Following the empirical evidence, the relatively young discipline of 'non-linear dynamics' has given us the mathematics to describe some of these things, and content ourselves that they are indeed theoretically possible. But what was Christ's assessment of Thomas? 'Because you have seen me, you have believed; blessed are they that have not seen and yet have believed' (John 20:29 NIV).

The authority of science is derived from its ability to provide profound, unifying, underlying patterns in the overpowering wealth of sense-data that reaches our minds. How can a study of repeatable phenomena today, give us a foundation to be sceptical about a straightforward description, of a unique series of miracles over six days? This account is given by a God whom we are prepared to trust to clearly relate historical events everywhere else in scripture, including the resurrection of our Saviour.

For many people the conflict derives from a mental picture of a Sunday-school child giving an account that conflicts with that of a university professor. The fundamental deciding factor is that the child's opinion is not his or her own. It derives from divine revelation in scripture. That of the professor and his peers is their own, and is derived from research by fallen minds in a fallen world.

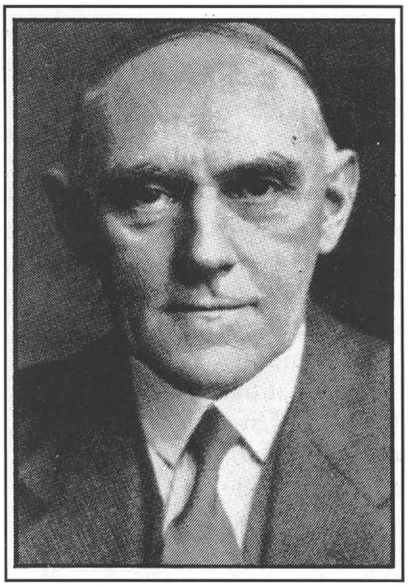
Have you ever struggled to understand the workings of a complicated second-hand hi-fi system? Your empirical research could be somewhat distorted if the system has become subtly flawed, and certain buttons or switches either don't work or work intermittently. Whatever one had learned by trial and error, one would have to defer to a person possessing a copy of the manufacturer's handbook. Even a child could thus say authoritatively how it was originally intended to work.

The Changing View of the late Professor Arthur Rendle-Short (1880–1953)

John Rendle-Short

MY FATHER was born in Bristol. He entered medical school in 1896 at the age of 16. He came from a non-academic, Christian Brethren family. At London University, he qualified with all the gold medals possible. His ambition was to become a medical missionary and, to further this end, he obtained a Diploma in Tropical Medicine, a Doctorate in Medicine (with another gold medal) and Fellowship of the Royal College of Surgeons.

But, in fact, these higher qualifications barred him from overseas service. He was considered too well qualified! So, he became a physiologist, a surgeon, a prolific writer on medical and Christian topics and, latterly, Professor of Surgery at the University of Bristol.



In a little diary, commenced in 1908, Arthur Rendle-Short (ARS) noted some of the formative influences in his early life: 'Books first, then men,' he wrote. He included Farrer's *Life of Christ.* He wrote, 'Bishop Westcott for the historical setting of the New Testament and the early church ... To Darwin's *Origin of Species* I owe more than I can say, and to Drummond's *Natural Law* for linking together my science and my faith ... From George Muller I learned the power of simple faith in God, to derive all practical principles from the Word of God, and to obey in simplicity whatever the consequences ... From St Francis of Assisi I learned the sweetness of Holy Lady Poverty, and the love of all created things.'

Because he saw the inroads evolutionary theory was making into belief in Scripture, he took the 'whimsical step' of adding a B.Sc. in geology to his medical course. Later he took a D.Sc. in the same subject—the only examination he failed. Country walks in my childhood were enlivened by his vast knowledge of nature. (In *Who's Who?* his hobbies were recorded as geology and naturalising).

Filled with Awe

The majesty of nature filled him with awe. He wrote, 'Every science fades into mystery. What is under the crust of the earth, and why? ... What is life? What is mind? ... Every page of physiology, pathology and medicine merely raises a dozen unanswerable questions. History too, begins in mist and is full of 'whys.' Yet God was so great that He planned it all and His power that He made it all. We are utterly incapable, apart from what He has told us, even to conceive His objects, His principles ... It is our part just to trust and to say, 'It is the will of God'.'

ARS's early scientific creed was Darwinism, yet as seen through the eyes of a Christian with a profound knowledge of Scripture. He believed God used and controlled the evolutionary method. Let me give a small selection of his early ideas.

From *A Summer Day's Reverie on a Cornish beach* (1903):

'... To the left the endless moaning, tossing, irresistible sea. My Father made it all. Those stars declare His glory; that sea and these hills and valleys and cliffs His power. Look at the rocks and see the shores and seas of long ago, look around and see how slow change is, then think what endless ages are hidden in the rock beneath you. See life preserved in those rocks, relics of the preparation He made for man. If the rocks spell ages, the fossils spell eternities. And all this was to provide and prepare the way for man.'

God made the World

And in 1910 from a sermon: '... It was according to His settled plan that He made the worlds and their elements—that He cooled the nebulous, the molten globe—that He gave the sun to give light and heat and that He made the earth, endless ages ago as habital place for life. He was preparing a place for us.'

'... Into some favoured dust, He elected to breathe the breath of life. Happy dust! To triumph over the whole inanimate creation—raised into another world—yet for no virtue of its own.'

'Ten thousand times the developing life of the world history was called to go forward to nobler, fitter things; the many chose the lower path; the few responded to the call. The many left their bones in the record of the rocks ... Till the advent of the fullest fruition of the earth: 'Man in our own image'.'

The Principles of Christians called the 'Open Brethren,' a book written in 1913, contains a chapter titled 'Problems of Inspiration,' in which ARS discusses scientific difficulties in the Bible. He concludes that the 'Noachian Deluge' included no more than the *then known* world [His italics].

Scientific Problems

He considered that the main scientific problems cluster 'about the origin of the world and of the human race.' He regarded it as 'highly unfortunate that nearly all defenders of the Bible ... lack scientific training, and thereby stumble young Christians.' He argued, 'Saving faith is not concerned with the interpretation of these chapters [of Genesis], but with the Lord Jesus Christ and His Atonement.' This would have been an appropriate comment for his day. But not now. Then, everyone had heard of Christ, of sin and the Law. But no longer. Evangelism today must begin at the beginning. Who is God? What is man? What if I have sinned? What is the point of Christ's death? Something of AJS's own spiritual and mental struggle can be seen at the end of the chapter on scientific difficulties. 'When we who have been taught from childhood that the Scriptures are inspired from cover to cover come into real touch ... with the evolutionary and other doctrines of the biological and anthropological sciences, we are strongly tempted to jump to the conclusion that the whole Bible is shaken from its throne. The scientific facts and theories are put before us in dogmatic form, as established truths ... We see the force of their illustrations and cannot escape the grip of their logic. So we think they are all right and the Christian revelation must be all wrong.'

In rebuttal, ARS could only appeal for patience and humility. 'After five to ten years of study and research into the underlying facts, when we begin to think for ourselves and perhaps to teach others, we find that around every island of knowledge there is a wide ocean of ignorance ... All science is edged with mystery.'

Some Scientific Christians

In conclusion he mentioned that, 'Some of the very princes of science have found it possible to be earnest Christians and believers in the Word of God. We recall with pride ...' and here it is interesting to learn the only three persons he considers. First, Lord Kelvin, the physicist who computed, by experiments on cooling, that the world could not possibly be more than 25 million years old. This was too short a time for Darwin to accept. The present requirement is about 4.5 thousand million years. Second, James Dana, professor of geology at Yale University, who although an orthodox Christian, boasted in 1880 that he had made Yale a stronghold of evolutionary science to 'correct the false dogma of the theological systems.' And finally there was poor George Romanes (see article in *Creation Ex Nihilo* March–May 1988).

None of these scientists had been active for at least 20 years. Surely, there could have been little comfort to be gained from them?

By the 1920s, AJS was much in demand as a student speaker. He was founder of the Inter-Varsity Fellowship of Evangelical Unions and for many years one of the two senior treasurers. At an IVF conference in Swanick in 1924, he spoke on the subject of Genesis and Geology. Here is a summary of his sermon notes (written on the back of a 'Notice of meeting' of some university committee!) [My additions are in square brackets}:

' 'One man's meat is another man's poison' therefore [I have been] silent till lately—publicly.

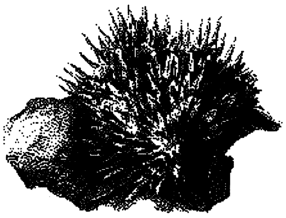
' Those who deal with this subject usually fall into two classes. [They say] —

'A. 'Of course, it's part of the Bible; world and every thing in it created in 4004 BC in 6 days. If so science and archæology don't agree with it.' Are all scientists liars?—No! ... perhaps we have interpreted Genesis wrongly!'

'B. 'Genesis a myth? [He considers various theories: J, E, P etc. and again answers]—No!'

ARS then gave his reasons for accepting the Bible as the Word of God. He was particularly anxious about 'The Fall,' which he calls: 'An impasse? Lots of problems in science bring us face to face with seemingly irreconcilable facts ... We can only wait patiently.' He discusses various theories which attempt to reconcile the apparently irreconcilable. In passing he mentions with approval Dawson and the recently discovered Piltdown Skull.

The sermon notes end with the comment—'No final solution possible today.'
Indeed, until the end of his life in many writings, this was to be the refrain—'We don't know enough yet. Have patience. Wait. God will give needed light in His good time.'



Later Studies

In the late 1920s and 1930s, ARS made a special study of archæology and the accuracy of the Bible. He wrote several books on the subject. But he dealt less with evolution—perhaps because he believed God's 'good time' had not yet come.
He returned to the subject of evolution after the Second World War, and in 1949 preached a sermon titled, The Problem of Man's Origin. His notes read:

A. *The Old Idea:* 4004 years BC, 6 days. All species separately created ex nihilo.
B. *New Idea:* Man ? million. Evolution by self-working process, pure chance, no plan. Man a slightly improved ape.
C. *True Idea:* 4004? ex nihilo? ...

Four years later, in 1953, the year of his sudden death, he preached in Dublin on Evolution. This time his notes commenced:
A. *The Old Idea:* 4004 BC. Six days.
B. *The New Idea:* Earth 2000 million years old. Life? Darwinian evolution self-working, depends on chance. Atheistic.
C. *The True Idea:* Belief of scientists *e.g.* Einstein [with a ? mark]; Lord Kelvin; Sir Ambrose Fleming. 4004BC / six days / separate species. What species mean. Deterioration by descent!

[The sermon concludes, in bold confident letters]:

Back to the Book

Order of Creation.

'Man in His own image.' Not enough to believe in God.

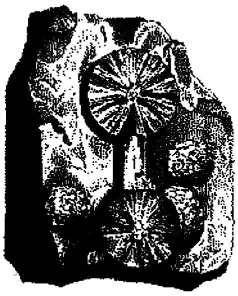
Why 7 days?—Sabbath.

Why *origin of woman?*—Otherwise might be just like animals—meet, mate, part.

Why the Fall?—Romans 5. 'All we like sheep.' Failure of race to improve. [Romans 5:12,14,15 reads—'...through one man [Adam], sin entered the world, and death through sin, and thus death spread to all men, because all sinned ... For is by one man's offence many died, much more the grace of God and the gift by grace of one Man, Jesus Christ, abounded to many.']
You will remember that in 1920 ARS wrote, 'The Fall, an Impasse? ... We can only wait patiently.' He had waited 30 years; but God had at last revealed the truth.

Why So Long and So Late?

I think the answer, for ARS, as for so many others, revolves around the matter of evidence. Scientific evidence against evolution and in favour of creation was virtually non-existent until the mid-1950s, as can be seen by the scant number of scientists he was able to cite. Remember the Piltdown fraud was exposed only in 1953, the year his last sermon was delivered. Since ARS does not mention such a dramatic finding, I doubt whether he knew about it.



Special Note:

I am particularly happy to publish this account of my father's beliefs. He has often been quoted as a prominent theistic evolutionist—which indeed he was for most of his life. I personally did not know he had changed his views until recently. It was while sorting through some of his old sermon notes and diaries, which had come into my hands, that I came to understand that he grasped at last the truth he had waited so patiently for all his life.

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New Fossil Find Shows a Whale with Hind Limbs

Evidence for evolutionary transformation?

David J. Tyler

DURING THE YEAR 1832, the inhabitants of Louisiana grew accustomed to the rains. The streams became turbid with sediments in suspension, and some broke their banks. In one place, the river Owachita flowed over rocks of the Early Tertiary system and around a small hill. The waterlogged ground became unstable and a part of the hillside slid down to the water's edge. About 13 metres below the original land surface, visitors to the landslip scar witnessed the fossilised remains of an imposing animal.

Close inspection revealed 28 large vertebrate bones extending along a line of about 130 metres. The first person to find the bones gathered some of them to use as andirons in his fireplace, but when Judge H. Bree realised the significance of the discovery, he retrieved all the remaining bones and forwarded them to a Dr. Harlan, who was competent to undertake an investigation. The vertebræ showed two very distinctive impressions in their lower part, and these features were reminiscent of a marine reptile (the Plesiosaur). As a result of this, Dr. Harlan concluded that the bones belonged to a new large extinct saurian which he named Basilosaurus, or 'King Lizard.'

Fragments of jaw and teeth, humerus and rib-bones were discovered at about the same time in Tertiary deposits in the state of Alabama. They came into the possession of Dr. Harlan who identified them also as Basilosaurus. These bones accompanied Harlan on a visit to London, when he took the opportunity to discuss them with his friend Dr. Richard Owen, who was the British Museum's leading expert on fossil animals. The teeth made the deepest impression on Owen, for they failed to demonstrate any of the known dental peculiarities of saurians. Purely from the evidence of the teeth, Owen was able to conclude that they had come from a mammalian animal, and most probably from the cetacean order (that is, the whales). Further investigations of other anatomical features served to reinforce the identification—and to justify renaming Basilosaurus as Zeuglodon, with the new name drawing attention to the distinctive tooth morphology. Owen's observations were published a few years later (1841) and no one has questioned the cetacean association since then.

The unusual features of the fossil remains were the subject of comment by Owen: references were made to the 'exaggerated condition' of the teeth, the 'remarkable and abrupt contraction' of the distal end of the humerus which is a cetacean character 'carried to an extreme,' and the 'extreme elongation of the body of the caudal vertebræ.' Consequently, Owen declared: 'We cannot hesitate in pronouncing the colossal Zeuglodon to have been one of the most extraordinary of the Mammalia which the revolutions of the globe have blotted out of the number of existing beings.' This latter reference to catastrophic extinctions is an expression of Owen's general perspective on Earth history: he was a creationist who believed in successive creations of animals and plants over geological time, and in successive catastrophes (or 'revolutions') which brought about their demise. The new name was not retained, and the genus Zeuglodon is regarded as a junior synonym of Basilosaurus. Further specimens of this fossil whale were discovered with the passing of time. Some fine examples were excavated in the 1890's in Alabama and one of these possessed some small pelvic bones including an articulating partial femur. By this time, Darwin's theory of evolution by natural selection had become widely accepted, and an evolutionary interpretation of these unusual bones was proposed. They were considered vestigial and functionless: a left-over from their unknown but inferred mammalian land ancestors. Bringing the situation up-to-date, two species are now known: *B. cetoides* from the USA, and *B. isis* from Egypt. The animal is considered to have been snake-like in appearance, reaching lengths of 16–22 metres and, due to its specialised vertebral column, must have moved in a serpentine manner. It is assigned to the sub-order *Archæoceti*, or 'primitive whales.'

The new discoveries have taken many by surprise! Recent work by Gingerich *et al.* (1990) has resulted in the discovery of numerous fossils of *B. isis*. Altogether, it is said that 243 partial skeletons have been identified. Several of them provided evidence for functional hind limb bones: none were complete and intact, but when taken together, the limbs could be reconstructed satisfactorily and analysed.

Gingerich *et al.* assert that these finds are direct evidence of evolutionary transformation: 'Retention of well-formed pelvic limbs in Basilosaurus corroborates the morphological primitiveness of archæocetes. Temporal and morphological intermediates are direct and important evidence of transition in evolution: an Eocene whale with functional hind limbs narrows the gap considerably between generalised Paleocene land mammals that used hind limbs in locomotion and Oligocene-Recent modern whales that lack pelvic limbs' (p.156).

There is little doubt that these finds are spectacular and of considerable importance. For a long time, the gap between whales and their supposed evolutionary ancestors has been too large to bridge, so any evidence of whales with feet is likely to be seized by evolutionists with great enthusiasm! However, it is the writer's opinion that the evolutionary conclusion quoted above is somewhat premature. We ask the question: 'Are the feet of Basilosaurus genuinely transitional?

1. Although the feet are very small, they are not degenerate. If Basilosaurus had evolved from a land mammal, enormous changes must have taken place. The animal was 16 metres long with a body less than 1 metre in diameter, and major differences with land mammals exist in the head, front limbs, and the rest of the skeletal structure. The little limbs are only about 50 cm long when extended and have no point of attachment with the animal's pelvis. Plenty of scope exists for degeneracy, but this is not observed. The authors write: 'Most bones are present; some elements are fused, but remaining joints are well formed with little suggestion of degeneracy' (p.156). This situation implies that functionality and design considerations should be given due weight and, instead of viewing the pelvic limbs as a relic of the past, they should be regarded as an integral part of the organism's structure.

2. The feet show specialised features. The patella had two stable positions. The limbs could be pulled in against the sides of the animal, or they could be extended in which case the knee was locked into position. This unusual situation was deduced after studying the detailed morphology of the bones. The authors conclude that the limbs were not used for any form of propulsion, but that they were suited for positioning and holding. 'Abduction of the femur and plantar flexion of the foot, with the knee locked in extension, probably enabled hind limbs to be used as guides during copulation, which may otherwise have been difficult in a serpentine aquatic mammal' (p.156).

3. Basilosaurus is not a transitional animal, but highly specialised. The 16 metre long serpent-like body can hardly be regarded as a good transition between land mammals and toothed or baleen whales. Owen's description of 'extraordinary,' 'extreme' and 'remarkable' features should surely be sufficient to challenge the idea that here is an animal near to the stem-whale! Indeed, many authorities deny that the archeocetes as a group are the precursors of modern cetaceans. Harrison and King (1980) state: 'They have been considered a highly specialised group that could not have been cetacean ancestors and that their cetacean features were the result of convergence or of parallel evolution' (p. 24). Gingerich's *et al.'s* view that the hind limbs of Basilosaurus narrows the gap between unknown 'generalised Paleocene land mammals' and 'modern whales' is in tension with everything else we know about this remarkable animal. We ask again: is it realistic to speak of a transitional limb on a highly specialised body? It is essential to evolutionary theory that whales are mammals that have lost their hind limbs, and so it is to be expected that evolutionists will conclude that the limbs of Basilosaurus are transitional (via deductive reasoning). However, the real issue is whether it is scientifically justified to reach this conclusion (via inductive reasoning). The lack of degeneracy, the evidences of functionality and the obvious specialisation are suggested here to argue against their transitional status. Evolutionists are so committed to the principle of transformation that they appear to have no interest in studying discontinuities. All their intellectual tools are geared to identifying relationships between organisms, and appear to be incapable of recognising the existence of gaps. Creationists have consistently argued for the principle of optimum design: organisms possess a morphology and features which are suited for life in specific ecological niches. Creationists also argue that homology can be understood as variations on a design theme. Aquatic mammals, like all mammals, reveal the mammalian blueprint with modifications. The diverse physiological and skeletal differences between cetaceans and land mammals reveal a major discontinuity which is totally unbridged by transitional organisms. Within this general creationist perspective, Basilosaurus can be viewed as a specialised form of whale, needing hind limbs on its serpent-like body in order to fulfil the Designer's intention that it should reproduce 'after its kind.'

In controversies of a technical nature, it is important to identify the main issues and not be lost by discussion of the details. In the case of Basilosaurus, there are two contradictory interpretations of the animal. The supporters of evolution consider that the discovery of functional hind limbs in a fossil whale is a major breakthrough—narrowing the gap between inferred ancestral land mammals and modern whales that lack pelvic limbs. This article has sought to demonstrate the fallaciousness of this view. It is argued here that there was nothing transitional about these tiny limbs, that the animal had limbs because it needed them, and that Basilosaurus was actually a highly specialised organism rather than an intermediate. The Christian does not have to squeeze Basilosaurus into an evolutionary mould, but is free to appreciate this extinct marine monster for what it was: one of the magnificent creatures of the sea that was designed by the Creator, brought into existence during the fifth day of creation week, and that still declares the exquisite handiwork and wisdom of the Living God.

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Methuselah

Graham A. Fisher

A brother, who was leading a Bible study, remarked about Methuselah that here was a man who lived 969 years yet, apart from his age and genealogy, we know nothing about him. Genesis 5:21–27 lists the name of his father (Enoch), how old he was when he became a father (187), whom his faithful son was (Lamech) and how old he was when he died.

Apart from a mention in Luke's genealogy of the faithful line of Christ going back to Adam (Luke 3:37), he is not mentioned at all anywhere else in Scripture. It is my contention, however, that we do know quite a lot about him despite the paucity of textual references.

The vexed question of his age

When people today scoff at the idea of a man living to the age of 969, they are usually saying more about themselves than about the problem. Firstly, they generally do not accept the inspiration of the Scriptures and forget that this is the Holy Spirit's record, not man's, which is found in Genesis. Secondly, they reveal that they have made a judgment out of ignorance based on assumptions and have never studied the matter at all. Consequently they suggest solutions which sound equally as silly to the tutored ear as the biblical facts sound to their untutored ears.

The most common suggestion as to how these ages in Genesis 5 came to be so long is to say that they have been exaggerated by a factor of 8, 9 or 10. To divide Methuselah's age by 10 would make him nearly 97 at death, which is clearly quite acceptable to the modern mind. The same can be said of the others but what is forgotten is that if their ages at death have to be divided thus, so do the ages at which they became fathers. Once you do that the absurdity of this solution becomes apparent. Noah becomes a father at 50 not 500 and Methuselah sires a son at just over 182, both of which are quite acceptable, but Enoch had Methuselah at 62! Most of the others are equally as absurd by the division method.

Other suggestions run along two lines. The first is that these 'ages' represent the importance of the patriarch concerned. Methuselah was thereby the most important because he was accorded the biggest 'age.' However men like Enoch and Noah in particular are viewed as far more important down the pages of the Bible than he is.

The second suggestion is that these are dynastic 'ages' rather like our Royal Family. Thus we have the Tudor family or the Stuarts—our current queen is the last of the Windsors and Charles will begin the Mountbatten family until it too ends with a queen (as they all do). Therefore, so the argument goes, the Methuselah family or dynasty lasted 969 years; the Jared dynasty was 962 years, etc. However, if 'Enoch' is to be viewed as a dynasty and not as an individual, then the whole dynasty must have been translated into heaven and did not see death (*c.f.* Heb.11:5)! Both the Hebrew writer and Jude (14) saw 'Enoch' as a man not a dynasty so the internal evidence of the Scriptures is against this notion.

Once the problem is studied, several things become apparent, the chief of which is that the world which was destroyed by the Flood was very different than the world in which we live to-day. It is quite true to say that people cannot live to these vast ages under present conditions but there is ample evidence in the Bible to suggest that the antediluvian world was physically very different. The main differences, which would have had a significant effect on the human life span, have to do with the atmosphere. The Earth was watered not by rain but by mist (Gen.2:6) and many believe that there was a thick water vapour canopy completely surrounding it. If the carbon dioxide content was very much higher—this would possibly slow maturation rates and increase the sizes of plants, animals and man as well as adding to their life spans. There is evidence that there was much more CO_2 available before the Flood. For example there was a luxuriant, tropical like vegetation cover over much of the Earth's surface, a tremendous amount of which was turned into coal by the Flood and/or the Ice Age catastrophe. The oceans were a good deal smaller (the Flood waters had to go somewhere) but there is evidence presented by the presence of precipitate limestones that a large percentage of available CO_2 became locked away as rock after the Flood, though the origin of these limestones is admittedly disputed.

The most harmful effects of all to life on the Earth are the ultra-violet rays from the sun. It is the job of the ozone layer to shield out these rays, (remove the ozone layer completely and all life would die in about two hours). A thicker ozone layer would provide a better shield and prolong life. Thus it is quite probable that the ozone layer was very much thicker and that it was reduced significantly to its present level by the breaking up of the atmosphere by the Flood (Patten, 1966). There is a good deal of work still to be done here but, once the fact that the atmosphere was very different before the Flood is grasped, it can readily be seen that such ages are not ridiculous at all. Indeed with any luck Methuselah could have reached 1000. So, why didn't he?—that is a much more interesting question.

The figures from Genesis 5

If we draw up a chart of the ages of the patriarchs listed in Genesis 5, we learn quite surprisingly that Methuselah died in the year 1656 AC (After Creation). It is surprising because this was also the year of the Flood. Since the Flood came in the second month of that year (Gen.7:11), it is reasonable to assume that Methuselah died in the first month as the last survivor of the antediluvian world with links back to Adam. He and his son Lamech were the only ones who knew all of the men listed in the genealogy thus he was the perfect link between the old order and the new which was unfolding. Lamech died five years before his dad. He had known Adam for a mere 56 years but Methuselah knew him for 243 years; he knew Noah for 600 years and Japheth, Noah's eldest, for 100 years.

The positive side of his life

This may seem interesting but of no value until we begin to realize that these figures reveal that there were other godly men living up to, or nearly up to, the Flood. It is reasonable to assume that Adam and Eve learned from God what they had to do after their sin and that they taught their children too. They were still teaching the ways of godliness to their families in the year 687 AC when Methuselah was born. There was a godly line of obedience and teaching down the years. Enoch, Methuselah's father was a pearl of righteousness and was privileged not to taste death so pure was his walk with God. Therefore Methuselah must have had the most wonderful teacher of all in the life of his father and would have been able to sit at Adam's feet learning all about the world since creation, but especially what it was like in Eden before the Fall and the folly of sin. He had the benefit of all of the accumulated knowledge there was at that time. He too had the duty to pass it on to his successors and he must have done that well because his grandson, Noah, was like his father, Enoch, and walked with God and was righteous in his generation. Methuselah was heir to all the godly teaching available and he maintained it in succeeding generations. He was an example of a good learner and a good teacher, obeying his parents and teaching his children to love and serve the Lord.

His family life

That he was a family man is attested by the words, 'and had other sons and daughters' (Gen.5:26), and there is ample evidence that he had about the same amount of success with them as we all seem to have, on average, today. He would be humbly proud of his faithful son Lamech, and his godly grandson Noah, and his three great grandsons, Japheth, Shem and Ham. He was there ready to assist and advise Noah as he began to build the Ark and preach about the coming Flood. Noah would have needed all the support possible from his father and grandfather at this time—the only survivors of the early days and the only two who knew all the patriarchs in the Genesis 5 genealogy. Noah's lads had not been born when the Ark was commissioned. Japheth did not appear until 20 years building had been done and Shem came two years later (*c.f.* Gen.5:32, 6:3, 7:6, 10:21, 11:10, NIV), and they would not have been too much help until they grew into their late teens at least. Methuselah was there right up to the end and was by Noah's side as the people of the day laughed at him. Noah was not quite as lone a voice as we often imagine. These were the high points in his life but what about his lows? The most obvious was the death of Lamech, his faithful son five years before the Flood and his own death. Death was not a common experience in those days. Of all the listed patriarchs, only Adam knew what it was like to lose a son by death as far as we know. Jared lost Enoch but this was a special case.

There was heartache too for him (and for most of the patriarchs) in the faithlessness of the majority of his children. They all 'had other sons and daughters' who must have become corrupted by the godlessness of the antediluvian world. We cannot give any statistics at this point but we can say with certainty that when he died, despite all his teaching and example, there was only one of his grandsons and three of his great grandsons who were faithful and loved the Lord. All the rest would be numbered amongst those who mocked at the idea of a flood. He was spared seeing them drown but, like any concerned Christian parent today, he must have wondered where he went wrong.

Conclusion

We can now see a man essentially like us all. He loved God and was used and blessed by God. It was not in God's plan to preserve him through the Flood because his name means 'When he dies it comes.' His death was a signal to Noah that all was ready to be accomplished and his mission to the wicked of his generation was nearly over. Methuselah did not make it to 1000 because the old order was passing and the new was not for him; his work was done.

He only rates a few verses amongst many in a simple genealogy but we do know quite a lot about him. You cannot be mentioned in the lists of the faithful in the Bible and be a nobody. However the only list we need to be concerned about being on is the one in the Lamb's Book of Life (Rev.13:8, 20:8). If our names are in it, we will join Methuselah and hear those beautiful words of welcome, 'Well done, good and faithful servant.' Methuselah will hear them for he is an example to us all.

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Reviews

Of Pandas and People, by P. Davis, D. H. Kenyon and C. R. Thaxton. Haughton Publishing Company, Texas, USA, Price £11.95 plus P&P. Available from: Creation Matters, bookstall of the BCS.

Reviewed by Wendy Sharpless, Biology Teacher

I WISH this book had been available years ago when I was still a theistic evolutionist. At that stage any books that quoted Scripture in support of creation just angered me and made me close my mind even more. This book is, however, unusual in that, although it puts over a creationist point of view, it contains no direct reference to God or to the Bible. It could therefore be acceptable reading for people who are not even sure that God exists or for Christians who cannot accept the historical truth of Genesis and still believe that evolution is the only scientifically valid interpretation of the biological evidence. It states the facts of modern biological knowledge and then goes on to show how these can be interpreted logically as the results of design by an intelligent cause, that is by a master intellect. It then leaves the reader to make up his own mind. I found this style thought provoking and as a teacher continually exposed to evolutionary concepts in biology textbooks, it help me to sort out the flaws in the evolutionary interpretations and the scientific validity of the creationist viewpoint.

This book contains an exceptionally lucid factual account of modern knowledge and understanding of the origin of life, genetics, origin of species, the fossil record and homology. One example of homology discussed is the comparison of the giant and red panda, hence the title of the book. It is an unusual book in that the first chapter is a simpler overview of the topics to be studied and this is followed by more meaty, in-depth chapters. The authors state that the book is written for students. The text is very clearly expressed and should be easily understood by advanced level biology students. It could be useful background reading to help consolidate their knowledge, although the evidence for evolution and the origin of life is no longer on most 'A' level syllabuses. It would also be useful for university students and teachers and lecturers in biology, especially those new to creationist ideas, to help them clarify their thoughts.

In the last chapter, addressed specifically to the teacher, one of the authors, C. B. Thaxton, argues that the proper alternative to a natural cause in science is not a supernatural cause, but an intelligent cause. This is scientifically valid as opposed to the philosophical terminology expressed in the dichotomy between Natural/Supernatural, *i.e.* Naturalism/Supernaturalism. Some Christians may feel that it is wrong to leave the Lord God of Creation out of a book about His creation and as a creationist, my initial impression was exactly that, but this omission makes it a very useful tool in that many people who would not read a specifically Christian creationist book might well read this one. It might sow the seeds of doubt about evolution and lead them to consider the possibility of the existence of a Creator God.

As it is printed with a double column format on each page, the book is easy to read quickly and it is written in a lively and interesting way. It is beautifully produced with glossy pages and there are excellent diagrams and photographs, many in colour including a giant panda on the front cover! It would make an attractive present and could be an acceptable addition to a secular school or college science library. (The details of the references mentioned in the book are to be found in the teachers' guide and could be made available through BCS.)

The Illustrated Origins Answer Book, by Paul S. Taylor. Films for Christ Association Inc., USA.

Reviewed by Nancy M. Darrall

THIS BOOK provides an excellent addition to creationist literature. It is most appropriate for those who want to know the basic arguments for Creation and to expose the lack of scientific evidence for evolution. However, it has additional value to many books published at this level, because the second half of the book provides source references and further details.

The first half of the book is divided into sections on the origin of the universe, the age of the earth, the origin of life, the origin of species, the origin of man and a final section on the fossil record. The style of writing is concise and easily understood, presented in short paragraphs, with a numbered reference system that takes the reader to the appropriate section in the second half of the book. Useful quotations are included in both parts. Armed with this book, the non-specialist will have confidence in discussion, because some further sources of information can be pointed out, many in the secular scientific press. The difficulty may come in obtaining some of these source publications if the reader does not have access to a good technical library and a range of creationist journals and publications (BCS will help with the latter if we can). Definitions of scientific terms are scattered throughout the book as appropriate, although more could have been usefully included and they are referenced in the index (a bold typeface here would have made the search easier). This book will provide a useful first reference source for those who need to answer questions in areas in which they are not a specialist. The very reasonable price and current availability in the UK are welcome news. (Available from Creation Resources Trust, Mead Farm, Downhead, West Camel, Yeovil, Somerset, BA22 7RQ at £5.50 plus 12% for post and package).

Seeing and Believing –

The Amazing Process of Human Vision

Sylvia Baker

WHAT IS THE PROCESS of human vision? How do we actually see? Writing in 1988, David Hubel said, 'We are far from understanding the perception of objects, even such comparatively simple ones as a circle, a triangle, or the letter A—indeed, we are far from even being able to come up with plausible hypotheses (Hubel, 1988a)**.' In trying to understand the brain and its role in vision, we are trying to unravel the workings of the most complicated structure known. While accepting that to fully understand vision might prove to be beyond us, we can still marvel at what has been discovered and seek to learn all that we can from it about the Lord whose design and invention it is.**

We have already seen that the visual information coming into the eye is first analyzed by the three layers of the retina. From there, the messages journey up the optic nerve to the brain, travelling at 300 mph. The optic nerve fibres gather into a bundle as they leave the eye and fan out again when they reach the lateral geniculate nucleus (see Figure 1) where they link up with lateral geniculate cells. The lateral geniculate cells will take the messages further into the brain. They join up with cells in the primary visual cortex (see Figure 1), a part of the brain which is also known as the striate cortex because of its striped appearance in section. The striate cortex is just the first of more than a dozen separate visual areas. All these connections, from the eye to the lateral geniculate, from the geniculate to the striate cortex and from the striate cortex further on in the hierarchy are topographically organized. This means that you can trace a continuous path as you move from the retina through to the deep areas of the cortex. In other words, each of the different brain areas contains an orderly representation of the visual field, just as the retina does. Presumably, each region of the brain is carrying out further processing of the information that it has received. Much is now known about the first two stages, the lateral geniculate and the striate cortex.

When the optic nerve fibres leave each eye, they first have to pass through the optic chiasm (Figure 1). Here about half the fibres cross to the opposite side of the brain and half stay on the same side. From the chiasm, most of the fibres go on to terminate in the two lateral geniculate bodies, but some go on to different destinations, for example to those dealing with eye movements and with the response of the pupil to light.

Each lateral geniculate nucleus contains about one and a half million cells. Each one receives input directly from optic nerve fibres and then sends these messages on to the cerebral cortex. However, the lateral geniculate bodies are not merely relay stations. They also receive fibres back from the cerebral cortex and from parts of the brain stem which play a role in attention or arousal. Single cells in the geniculate make the same kind of responses to light as do retinal ganglion cells, and therefore do not seem to be processing the visual message any further, so we do not yet understand the role of these various interconnections. Each lateral geniculate body is divided into six layers of cells. Fibres from the six layers combine into a broad band called the 'optic radiations' (see Figure 1) which proceed to the primary visual cortex. Here the fibres fan out in a regular way and distribute themselves to make a single orderly map.

The cerebral cortex, of which the primary visual cortex is a part, has had this said of it (Hubel and Weisel, 1979), 'Viewed as a kind of invention by evolution, the cerebral cortex must be one of the great success stories in the history of living things.'

To visualise the structure of the cortex, imagine a football perhaps twice the size of the head which has been deflated and crumpled up to fit inside the skull. The crumpled skin of the football would then represent the cortex. The cortex contains a huge number of cells, at least 10^{10} of them!

The primary visual, or striate, cortex is a region 2mm thick with a surface area of several square centimetres. It contains about 200 million cells. What contribution do these cells make to the process of seeing? American physiologists David Hubel and Tolston Wiesel in the late 50's and early 60's found that the first thing that the visual cortex does is to rearrange the information coming in so that these cortical cells respond, not to spots of light, but to line segments set in specific positions. In 1958, they were recording from the cortex of the cat and managed to get a stable situation which enabled them to record from one cell for about nine hours. They tried everything they could think of to get this cell to fire. They were mainly

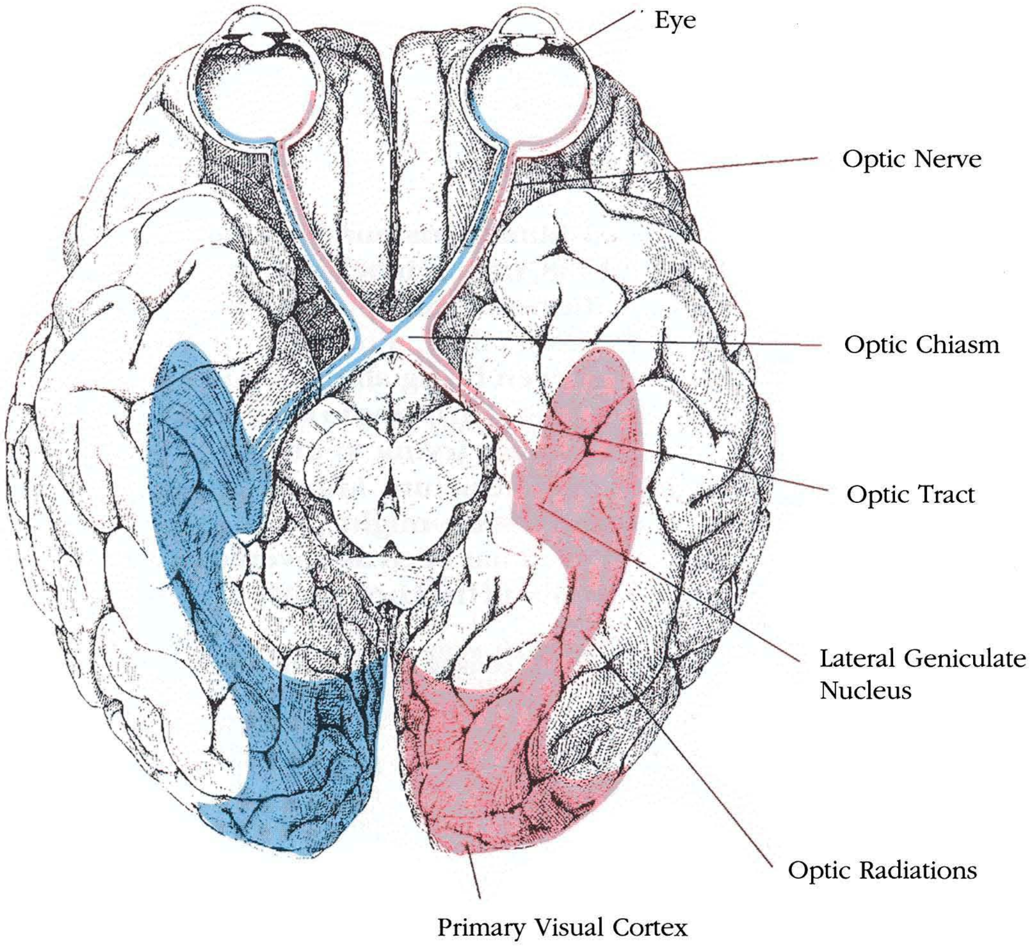

Fig. 1. The Visual Path

using white circular spots and black spots, since these had been so successful in producing responses from retinal cells. The black dots were glued on to slides and the white spots were produced by drilling a small hole in a slide. Eventually they realised that they were getting a response from the cell, but couldn't think exactly what was causing it. Finally they realised that it was the shadow cast by the edge of the glass slide as it slid into position. To their excitement they found that the edge worked only when its shadow was swept across one small part of the retina and that the edge had to be in exactly the right orientation (see Figure 2).

That discovery was just the beginning. It was eventually realised that there were two types of cortical cells. A 'simple' cell (see Figure 3) will respond to a line stimulus only in a particular part of its field. A complex cell will respond to a precisely oriented line regardless of where it is in its field and also to one moving in a particular direction. The cells seem to be in columns with all the cells in a particular column responding to lines set in a certain orientation.

Hubel and Wiesel next wondered whether neighbouring regions of the cortex were related to each other in any systematic way or whether cells responding to all the possible line orientations were just scattered at random all over the cortex. They said (Hubel and Weisel, 1979), 'We began to study these questions simply by penetrating the cortex obliquely or parallel to the surface. When we first did this experiment in 1961, the result was so surprising that we could hardly believe it. Instead of a random assortment of successive orientations, there was an amazing orderliness. Each time the electrode moved forward as little as 25 or 50 micrometers (thousandths of a mm) the optimal orientation changed by a small step, about 10 degrees on average; the steps continued in the same direction, clockwise or counter clockwise through a total angle of anywhere from 90–270 degrees.'

Why was this result so surprising to them? Surely because they were assuming that the brain had arisen by a random evolutionary process. Such an ordered result would come as no surprise at all to those who believe that the brain was designed by a Creator; indeed, it would be what they would have predicted.

Thirty years further on from that original research, we now realize that the simple and complex cells are analyzing every tiny part of the visual field for all possible orientations and for dark lines, light lines and edges. It seems that no two cells from the striate cortex do exactly the same thing.

To summarise, it seems that a particular cell is so connected as to respond to only one line orientation and one movement direction and that these connections are laid down in duplicate copies, one from each eye. Most of these connections seem to be wired up and ready for action at birth. It is also now known that there are regions in the striate cortex, small 'blobs' like islands in an ocean, which are specialised for responding to colour. What we do not yet know is how all this information is finally assembled to allow us to see the whole scene.

Evolutionary Views

We have been considering the most complicated system and process known to man. This system is believed by many to have evolved by a process of random chance which did not include any external direction, planning or design. Such an unlikely opinion would surely not be held unless there was a considerable body of evidence to back it up. What then is the evidence to support the view that vision has evolved?

The problem with considering the supposed evolution of the eye is that different kinds of animals have different kinds of eyes. It is not that 'simple' creatures have 'simple' eyes; often their eyes are extremely complex. However, these eyes are completely different from the vertebrate eye. They operate on different principles and have completely different structures. There are in fact ten completely different types of eye that are known (Land, 1981). Some use lenses, some do not. Some work by reflection, some by refraction. Each of the ten types works perfectly well for its owner but there are no intermediate forms between the different types and it is impossible to imagine gradual changes by which one type could alter into another.

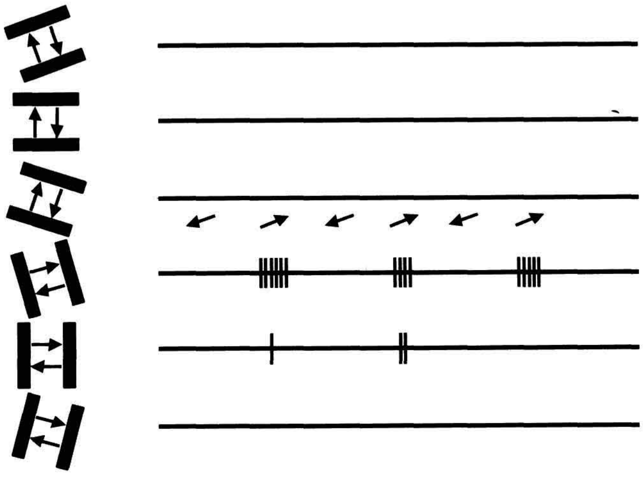

Fig. 2.

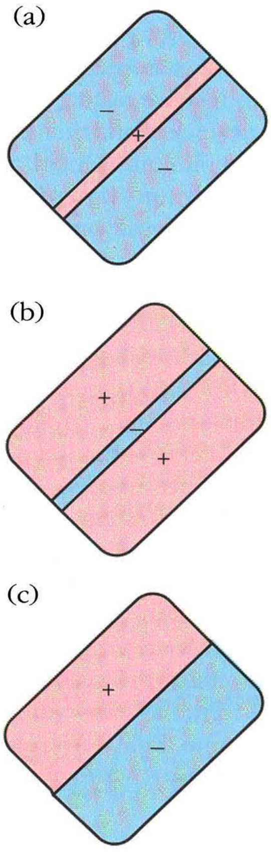

Fig. 3.

Surely the fossil record must provide us with evidence for the evolution of the eye? In fact, eye structure is very rarely preserved in a fossil. The earliest known fossil eye belongs to the trilobites, found in Cambrian rock. This creature had a highly sophisticated visual system which requires quite a knowledge of physics before it can be understood (Tyler, 1983). We certainly do not find primitive eyes gradually turning into more complex ones anywhere in the fossil record.

Turning, then, to comparative anatomy as the only means of acquiring some understanding of the evolution of the eye, the evolutionist finds himself up against even bigger problems. Not only is it impossible to arrange eyes in a neat ascending order as would be required by the theory of evolution, but there are some anomalies that it is impossible to explain away. For example, squids and octopuses have eyes very similar to our own, while snakes are supposed to have evolved from lizards, but their visual cells have no similarity to those of the lizards from which they are supposed to have been derived.

The supposed evolution of colour vision is fraught with particular problems. Many 'lower' animals possess excellent colour vision. It is highly developed in birds and fish and in insects such as bees and dragonflies. However, when we reach the mammals, mice, rats, rabbits, cats and dogs have very poor colour vision or none at all. Primates (humans, apes and most monkeys) have excellent colour vision. In an attempt to explain these anomalies, evolutionists make statements such as these: 'Among vertebrates, colour sense occurs sporadically having been downgraded or even lost and then re-invented many times in the course of evolution.' (Hubel, 1988b), or, 'Eyes have arisen independently forty times in evolution. It led to the particular direction of development.' (Laverack and Cosens, 1981).

In fact, it is admitted that, 'The structure of the eye tells more about the light environment of an animal than it does about the comparative history of the vertebrates' (Gleickstein, 1976). This is exactly what those of us who believe in a Creator would expect. Put another way, it means that a creature's eye has been designed to work best in that particular environment in which it lives. For example, there are thousands of species of teleost fish occupying a wide range of aquatic habitats ranging through many different light zones. Apparently, 'Their eyes can differ so dramatically in size, shape, retinal organization and colour sensitivity that one would never expect from examining the eyes alone that the species are closely related. On the other hand, unrelated species inhabiting the same light zone can show remarkable similarities in their visual systems' (Levine and MacNichol, 1982).

Evolutionists are constantly forced to acknowledge how perfectly designed eyes are. For example (Freese, 1977), we are told that, 'Nature has evolved truly startling visual organs for each animal has been given the very optical tools it specifically needs to do the work it must in order to survive ... For the many specialised needs, Nature has forged innumerable means ... Nature devises all sorts of ways for adapting eyes to special uses and conditions.'

It is the following kinds of examples that produce this reaction. The fiddler crab spends much of its time buried in the sand. It is able to raise its eyes on stalks, like a pair of periscopes. The tarsier lives in trees and hunts for insects at night. It can turn its head through 180 degrees and has enormous bulging eyes to see in dim light. The owl also hunts at night, has very large eyes and can turn its head right round so that it can look directly backwards. Flatfish, such as the flounder, start out in life swimming near the ocean's surface with one eye on each side of their heads. Gradually one eye moves across the top of the flatfish's head to the other side and the fish slowly sinks to the bottom with the eyeless side down. In some cases, the dorsal fin also moves forward to the head and in these cases the eye then moves across between the head and the fin so that the eye seems actually to go through the head from one side to the other!

Graham Martin (1990) has made a study of the Manx shearwater and has compared the detailed structure of its eye with that of the feral pigeon. Manx shearwaters spend most of their time flying over the Atlantic ocean and come ashore only to breed. They feed by day but always delay returning to their breeding colonies until after dark. How do they manage to find the correct breeding burrow in the pitch black? The pigeon, on the other hand, is entirely a daytime species. It was found that although the eyes of pigeons and Manx shearwaters are almost identical in size and overall shape, their optical designs turned out to be quite different. In the shearwater, it is the lens which does most of the bending of the light to focus it on to the retina, in the pigeon it is not the lens but the cornea. The result of this is that the shearwater has a shorter focal length which would give it a smaller but brighter image compared with a pigeon viewing the same scene. Also, the shearwater proved to have a most unusual distribution of ganglion cells in the retina. Studies such as these demonstrate the subtle differences in design which fit a creature's vision to its lifestyle.

We have been considering the miracle of vision. An ambiguous, flickering, constantly changing image on the retina is analyzed by the brain to produce a totally clear and understandable description of the outside world. We have seen that there is no evidence that this system evolved and that both Darwin and modern scientists recognise the problem that it poses for the theory of evolution.

Surely it is time to ascribe to the Lord, to Him who formed the eye, the glory due to His name.

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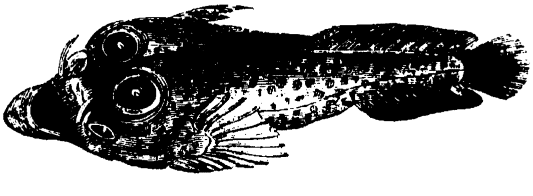


The Decay in the Velocity of Light:

A Statistical Critique of Norman and Setterfield

Colin Reeves

SOME YEARS AGO Barry Setterfield published a lengthy paper in which he revived the debate in secular journals between 1924 and 1944 that the velocity of light was not constant. Michelson maintained that he could see a reduction in his own measurements from 1879, 1924 and 1926. Setterfield considered that it had decreased significantly over the last three centuries, and he derived a curve—the 'cosec-squared law'—which purported to show exactly how it had been decreasing.

More recently, in an extensive revision of this paper, Norman and Setterfield [1] have produced further evidence in support of the original thesis. Here, they argue for a different curve, and consider some of its implications in a supplement [2] to the main paper. The latter paper will be referred to as NS1 in what follows, with the supplement referred to as NS2. As is pointed out in the latter, if their theory is true, it would go a long way towards reconciling biblical chronology with astronomical and geological data. In support of their claim, two main methods are used. Firstly, there are theoretical arguments, drawing on the scientific discipline of physics. Secondly, there is an extensive analysis of empirical data on the many determinations of the velocity of light over the past 320 years. The latter rests on the techniques of the discipline of statistics, in particular the method of regression analysis. Their arguments from theoretical physics have been considered elsewhere (see Peet [3] for some references), but it is interesting that the assumption of the constancy of the velocity of light has recently been questioned by some physicists quite independently of Norman and Setterfield. For instance, Troitskii [4] constructs a cosmological model for explaining the red shift by postulating a decay in the speed of light, while Sparkes [5] in an article suggested by reading Hawking's *'A Brief History of Time,'* points to the quasi-religious faith in the constancy of the velocity of light that is at the root of current cosmological theories. It is not the purpose of this paper to examine the physics of NS1, however; rather to carry out an evaluation of their statistical methodology.

The Method of Regression Analysis

Statisticians have developed the method of regression analysis to model the relationship between two or more variables. In the simplest case, we have two variables, one—the *dependent* variable—whose value changes in accordance with variations in the value of the other—the *independent* or *explanatory* variable. Often this relationship is a straight line: that is, it can be expressed as a formula

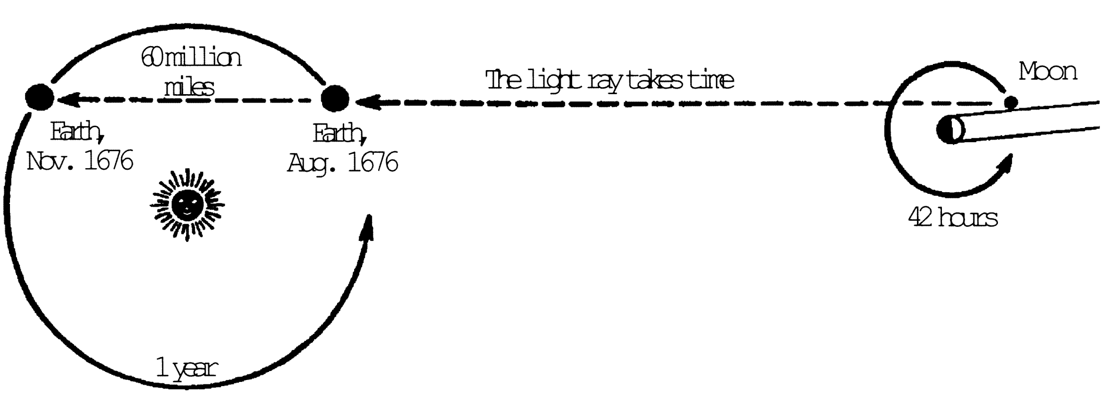
$$Y = a + bX$$

where Y is the dependent variable
and X is the independent variable.

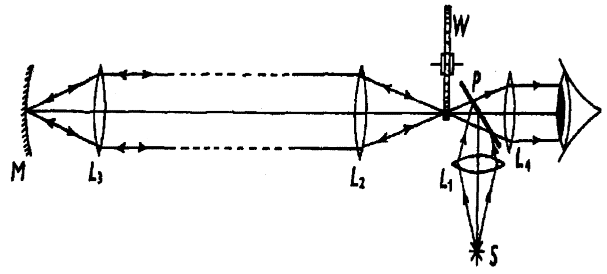
Of course this is only a statistical statement of what happens 'on the average': in any real situation there will be a multitude of other influences on Y besides the effect of X, so that for an actual 'experiment' with n pairs of values (x_i, y_i), the relationship will be

$$y_i = a + bx_i + e_i$$

where e_i is an error representing the variation in y_i that is not explained by its dependence on x.



Romer, 1676



Fizeau, 1849

However, on the basis of certain assumptions about the behaviour of these errors, it is possible to derive expressions which give the values of the parameters *a* and *b* which 'best fit' the given data.

These expressions can be found in any text-book of statistics, and can be calculated automatically by any statistical computer package, but a crucial—and often neglected—part of the analysis is to check the validity of the assumptions made about the errors. Again, the details can be found in statistical textbooks, but for the benefit of readers without statistical training, a basic introduction is given here.

These assumptions are as follows:

- A1 the expected value of the errors is 0 (*i.e.* 'on the average' there is no bias).
- A2 the variance of the errors is constant (*i.e.* the errors do not tend to be smaller or larger in any systematic way).
- A3 the errors are uncorrelated with each other (*i.e.* the value of one error is not influenced by the value of any other error).

In many cases, the relationship between two variables is *non-linear*, for instance, it could be a quadratic curve:

$$y_i = a + bx_i + cx_i^2 + e_i .$$

This is only slightly more difficult to fit than a straight line. A more complicated situation arises when a curve is also non-linear in the *parameters*; for example, one curve suggested by NS1 for the decay in the speed of light is

$$c_i = \sqrt{a + (b + dt_i)\exp(-kt_i)} + e_i .$$

where *a, b, k, d* are parameters, *t* is the time expressed as the year AD, *e* represents the error, and exp (.) is the exponential function. Fitting such an equation can be a very difficult problem. Whatever the particular type of curve under investigation, exactly the same assumptions are made about the errors.

It is this method that Norman and Setterfield have used to fit their curves relating *measurements of c* (in statistical terms, the dependent variable) to the *time at which the measurements were made* (the explanatory variable). It does not appear that they have done the final step of such an analysis, and carried out a check on the three assumptions described above.

Checking the Assumptions

This check is normally done by means of various *residual plots*: a residual r is the *estimate* of the error e at a given point, *i.e.* the amount 'left over' after the dependence on the explanatory variable has been allowed for. For instance, in a linear model,

$$r_i = y_i - \hat{a} - \hat{b}x_i .$$

(The ^ symbols over *a* and *b* indicate that we are referring to *estimates* of the true—but unknown—values of *a* and *b*; these estimates have been obtained from the particular set of observations we are fitting.)

A plot of r_i against the explanatory variable x, or against the *fitted* values of the dependent variable y will often reveal if assumption A2 is violated. If the residuals are scattered randomly, it suggests the assumptions are plausible; on the other hand, a pattern of some kind suggests that one or more of the assumptions is invalid. Another possibility is to plot the *absolute value* of ignoring its sign). A characteristic of such plots when A2 is untrue is a pattern such as that shown below in figure 1:

Here the pattern is signalling that the size of the error tends to increase as the y-value increases, in contravention of the assumption A2. By way of contrast, the pattern in figure 2 is typical of a set of residuals for which A2 is valid.

A numerical assessment can also be given by calculating a *rank correlation coefficient* between the absolute value of the residuals and either *x* or the fitted-*y* values. If this is significantly different from 0, it casts doubt on the validity of A2.

Assumption A3 is often harder to check, except in the case where the variables form a *time series*, which is of course the case here. In such cases, a plot of the residuals against

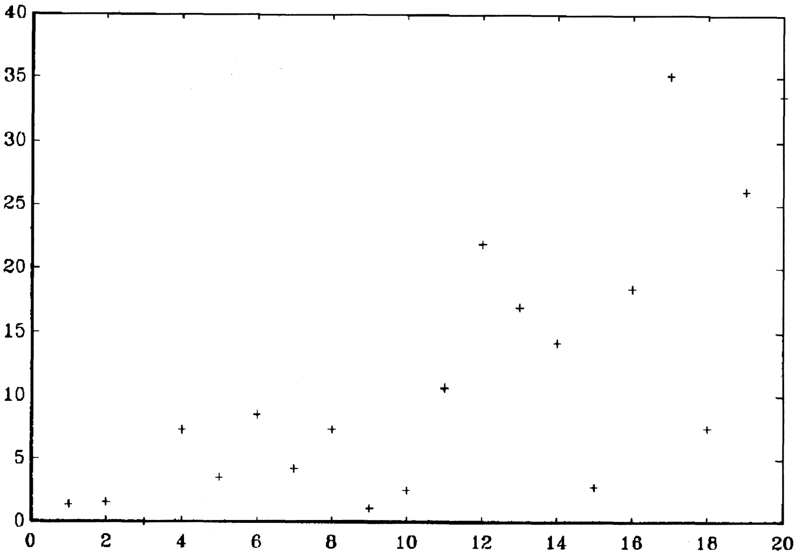


Fig. 1. Absolute Residuals for Non-Constant Errors

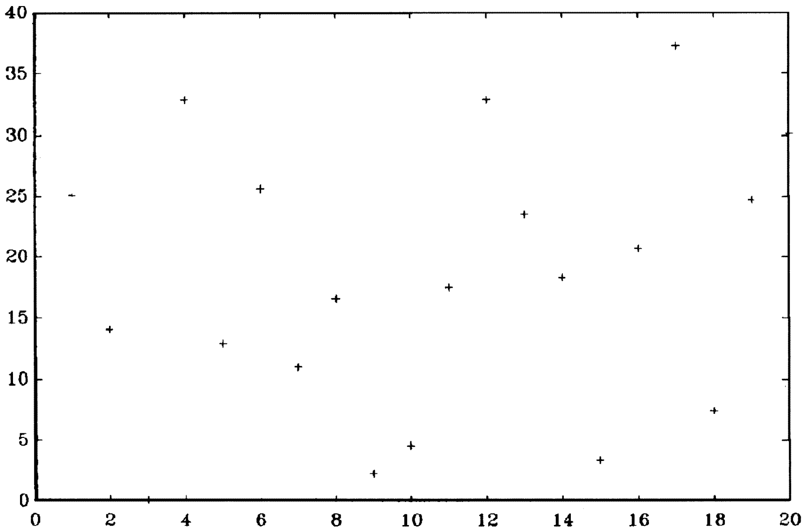


Fig. 2. Absolute Residuals for Non-Constant Errors

time will show a pattern if A3 is violated. When this happens, the errors are said to be *auto-correlated*, and again a numerical assessment can be made by using the *Durbin-Watson statistic*. If the value of this statistic is significantly different from 2, it casts doubt on the validity of A3.

The Velocity of Light Data

Anyone attempting to repeat the work of Norman and Setterfield is faced at once with a problem: there is *too much* data! NS1 presents data on determinations of the speed of light from many sources, using many different methods, over a period of more than three centuries. There is a large number of tables and graphs of the values of *c*, and it is not always clear just what each is meant to show. One table, Table 11, is said to show the 57 most reliable measurements of *c*, although on what grounds this particular set of values is selected is again unclear.

However, in seeking to evaluate their arguments from a statistical viewpoint, we need some fixed point, so in what follows, it is these values, and the various models fitted to them, which are under consideration. Norman and Setterfield consider many curves, but the one they put most credence in appears to be the following—the 'critically damped' curve described above:

$$c = \sqrt{a + (b + dt)\exp(-kt)} + e\,.$$

First, the data of Table 11 of NS1 was used to try to fit this curve using the well-known statistical computing package GENSTAT. As the function is severely non-linear in its parameters, this is fairly difficult, and it needed several attempts, starting with different initial values of the four parameters, to produce a result. The values obtained were a little different from those reported by NS1 (the software they used is not stated), and in fact gave a slightly better fit as measured by the 'R-squared' coefficient.

Table 1—Parameter Values

	NS1	GENSTAT
a	$9.029\text{x}10^{10}$	$9.000\text{x}10^{10}$
b	$4.590\text{x}10^{13}$	$4.001\text{x}10^{13}$
k	0.0048	0.0050
d	$-2.60\text{x}10^{10}$	$-2.16\text{x}10^{10}$
R-squared	95.14%	95.60%

Although these differences seem slight, it is worth pointing out what happens if they were to be used to extrapolate backwards. For example, NS1's figures predict a value of $18\text{x}10^{10}$ km/sec for *c* in 4000 BC, whereas the 'better' figures obtained above predict a value of $24\text{x}10^{10}$ km/sec—an increase of 33%.

Such large discrepancies point up the danger of extrapolation referred to by Peet [3]. How can we really be confident of a particular model which purports to describe the decay in the speed of light over thousands of years when we only have data relating to the last 3 centuries? If the curvature of the model were similar over a wide range of time, there might be some chance, but that is definitely not the case here. In NS2, it is argued that this curve gives dates that agree remarkably precisely with certain astronomical and geological events. In view of the sensitivity of the curve to small changes, as demonstrated above, this argument must be doubtful. A model as sensitive as this is clearly of little use in a *predictive* sense.

But is it any use purely in a *descriptive* way? To answer this question, we need to assess the residual plots. As the residuals are very similar for both sets of parameter values, this is only reported for the NS1 figures. A plot of absolute residuals against fitted-*y* values is shown as figure 3; a time-series plot is shown as figure 4.

In both cases, it is clear that the assumption A2 is invalid;* this is reinforced by the value of the rank-correlation statistic which was (in a statistical sense) highly significant. The Durbin-Watson statistic was also calculated, but its statistical significance was less pronounced; nevertheless,

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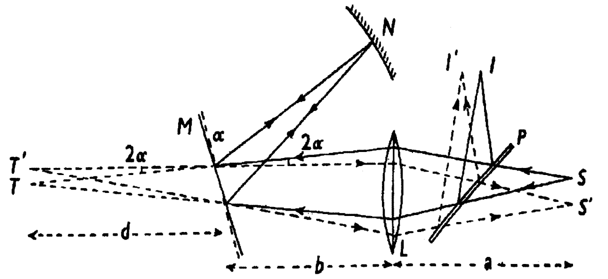
* See endnote



Foucault, 1850

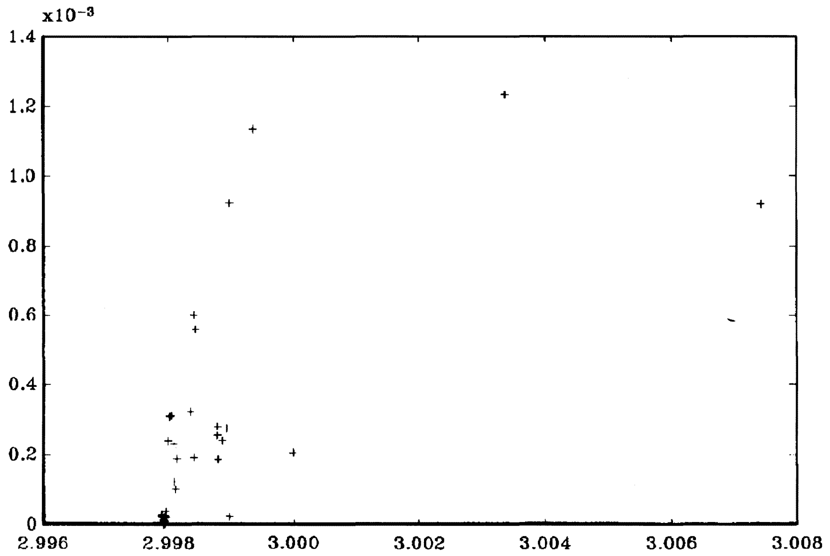


Fig. 3. Absolute Reisduals v. Fitted Values

the time-series plot does appear to show a pattern, and many statisticians would suspect that A3 is invalid too. Thus, any parameter values produced by the regression methodology will be of dubious merit.

NS1 puts forward several other curves which fit the data almost as well. Similar residual plots were constructed for some of these, with similar results. A linear model was also fitted, but the residuals clearly show *some* apparent curvature, and a straight line decay model fits less well than any of the curves.

However, they all possess the same characteristics as the 'preferred' curve discussed above: the degree of curvature is small over the region for which data is available, but (if the curve exists) is enormous over the whole backward range of time.

To summarise, *all* of the proposed models were significantly different from a model which just assumes that the values are a constant with regard to time, but in *none* of the cases examined could we justify the underlying assumptions used to fit such models.

In such circumstances, statisticians usually resort to carrying out transformations of the variables, or else using *weighted* regression techniques in an attempt to obtain more reasonable estimates of the model parameters. In this case, it is known that some of the measurements are much more reliable than others, and this should really be incorporated in the modelling process by giving less weight to less reliable points. NS1 actually give estimates of the probable error for some values, but apparently made no use of them. The *least* reliable values are by and large the ones which contribute *most* to the apparent decay. In fact, it is very difficult to employ this information in fitting complex non-linear models. It is possible to use it for a straight line decay; a weighted linear regression using weights inversely proportional to the probable error gave a decay of 0.9 km/s per year, compared to 2.8 km/s for the unweighted case.

Another important procedure is to check the data for *outliers* which have a disproportionate influence on the model. For the NS1 data, there are some obvious outliers—the Bradley and Lindenau figures, obtained in the 18th century, while several others have considerable influence—nearly all the pre-20th century values. And these, as already pointed out, are regarded as the least reliable measurements.

Omitting the first two values (Bradley and Lindenau) in a weighted linear regression produces a decay of 0.42 km/s per year, while omitting the first six values further reduces it to 0.28.

The Effect of Experimental Methodology

Another factor which has been ignored by NS1 is the effect of different experimental methods used in order to estimate the value of *c*. From a statistician's viewpoint, it is highly dangerous to fit a model which treats all determinations of *c* alike when it is *known* that they were not all obtained in the same way!

A further analysis was therefore carried out using the method of *Analysis of Covariance*; a description of this method can be found in many statistical textbooks, but for our purposes it is sufficient to note that it is equivalent to

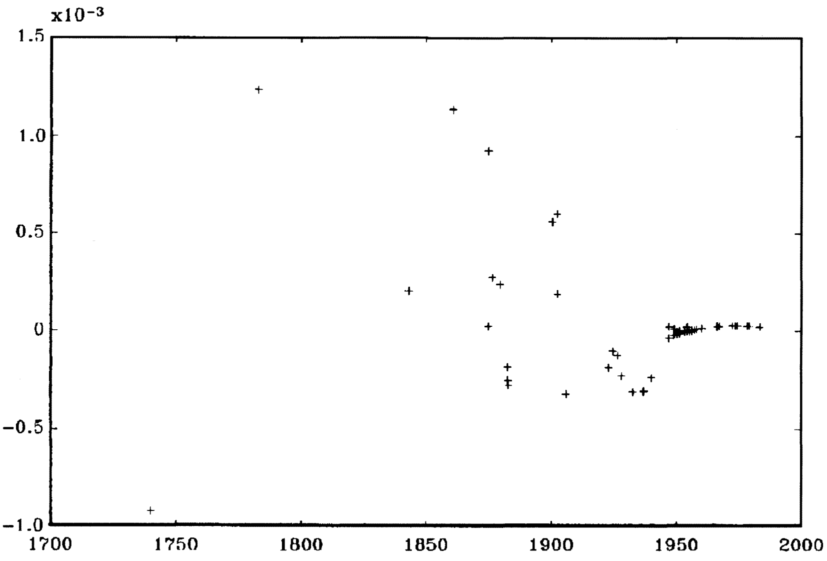
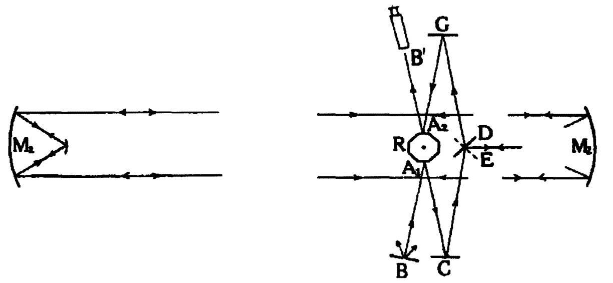


Fig. 4. Residuals v. Time



Michelson, 1880–1926

regression on many variables where some of them (the non-numerical factors) are 'dummies.'

This can be expressed by the following simple model:

$$c = a + m_k + bt + e$$

where m_k is a parameter corresponding to method k.

NS1 identify 17 different experimental methods, and a fit of the above model using these factors gave an excellent fit (R-squared = 97.13%) in which both the method factor and time (again expressed as the year AD) were significant. The 'decay' is 5.44 km/s per year.

With this approach, residual analysis can also be carried out, although the fact that we have (on average) only about 3 measurements per method means we must be cautious in our interpretation. Having made this caveat, it is still worth recording that there were certainly no obvious patterns remaining when the method factor has been included in the model.

There were however some outliers, and although less acute, the problem of the reliability of the early data remained. The analysis was repeated after omitting the first two values, which gave a decay of 2.87 km/s per year; omitting the first six values reduced it to 0.72 which was no longer statistically significant.

Conclusions

To make a full evaluation of all the data collected and analysis performed by NS1 would be a major research project. It is perhaps something that ought to be done; it would require a thorough independent investigation of all known measurements of c; criteria agreed beforehand for the inclusion or exclusion of particular determinations from a final database, and an agreed statistical methodology for testing the hypothesis that c has decreased.

However, I would make the following comments based on the work reported above.

1. The basic statistical methodology of NS1 is flawed by the reliance on assumptions about the error structure of their models which a standard residual analysis suggests are invalid.
2. The arguments in NS2 for the coincidence of astronomical and geological events with dates derived from the 'critically damped' curve are based on foundations that have little statistical support.
3. There does appear to be some grounds for asserting that the *measured value* of c has indeed decreased over the last three centuries. This is of course different from proposing that the real value of c has decreased. If physicists can indeed come up with a plausible model for such behaviour, it would strengthen the case for the latter proposition.
4. An alternative *statistical* explanation of the NS1 data is certainly possible, and one such alternative has been examined which takes account of the method used to determine c. There may be other factors which are not considered by NS1.

In conclusion, the work of Norman and Setterfield is important in stimulating scientific research into the question of atomic and cosmological 'constants.' Modern cosmological theories have the ambitious aim of giving 'a complete description of the universe.' It is important to realise that such theories are only as good as their presuppositions, and that the invariant nature of these constants is one of the most important of these assumptions.

* *Statistical significance* is a technical term; its meaning is as follows. We ask the question: if the assumption we are making is true, what is the chance that we would observe the particular data that we have obtained? This can be calculated from probability theory, and if the answer is that the chance is very small, this leads us to question our initial assumption, and the result is said to be statistically significant.

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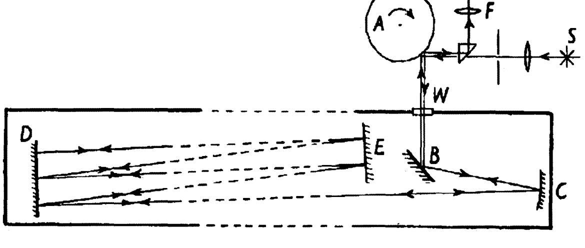


Michelson, Pearson & Pease, 1929–33

Haemoglobin

A Pedagogic Protein

John Ling

PRICK YOURSELF with a needle or let the breadknife slip and there it is—that sticky, red stuff—everywhere. And why is blood red? Because it contains haemoglobin, a marvellous molecule and best known of the body's pigments. It was back in 1864 that Felix Hoppe-Seyler of Tübingen first named it haemoglobin and as its name suggests, this molecule can be cleaved into two structural components—haem (sometimes spelled heme) and globin.

What a fascinating molecule it is. When you think of protein molecules, you probably think of enzymes, but haemoglobin is a splendid example of a non-enzymic protein that possesses bioactivity. Indeed because of its amazing activity, Jacques Monod once called it an 'honorary enzyme.'

There is much to impress about haemoglobin. If you are healthy, then there are about 2.5 x 10^{13} red blood cells in your circulation. And how many haemoglobin molecules are there in each one of your red blood cells? About 280 million. And each of these haemoglobin molecules is composed of something like 10,000 atoms—hydrogen, carbon, nitrogen, oxygen, sulphur and iron. At a quite different level, it is impressive to note that haemoglobin was the first protein ever to be crystallised—and that was some 90 or so years before the first enzyme, urease. Furthermore, haemoglobin has been the subject of more research than any other protein. Much of what we know about protein structure and function was first discovered in haemoglobin. It has generated interest and excitement in the scientific world for decades and it still does. Indeed, there is a scientific journal, called *Hemoglobin* that is dedicated to publishing research on just this one protein.

So what can be learned from a quick look at haemoglobin? Some biochemistry, a dose of biology, a little molecular biology, a dash of genetics, a smattering of medical science and a scornful glance at some evolutionary theory. It can also teach us something of the history and character of the scientific enterprise. In short, it is a molecule that can broaden our scientific horizons and unify much of our biological understanding. We should never fear to study and probe our world—to seek to understand what an infinite, yet rational Creator had made and sustains. Now that is a noble and exciting enterprise!

The Distribution of Haemoglobin

It is not only you and me that carry haemoglobin in our arteries and veins. In fact, haemoglobin is distributed throughout the biosphere. True, it is not found in bacteria (or any other prokaryotic cell), but it does occur in some yeasts and protozoa and a wide range of invertebrate animals, like *daphnia*, the water flea and some worms and some insects and many, many more. In most invertebrate systems, haemoglobin does not occur bound in blood cells, but free in so-called haemolymph. And a compound closely related to haemoglobin, called leghaemoglobin, even occurs in some plants—in the root nodules of *leguminosae*, the legume family that includes beans and lentils.

So although haemoglobin's distribution is wide, it is uneven, especially among the invertebrates. This observation—and haemoglobin appears to be a remarkably favourite subject for the proclamations of evolutionists—has led some, such as Maclean (1978), to suggest that haemoglobin 'has evolved as an oxygen-carrying pigment more than once, prior to its final acceptance as the main oxygen carrier of vertebrate circulatory systems' and 'even the concentration of the pigment [haemoglobin] in specialised blood cells has therefore been anticipated early in evolution.'

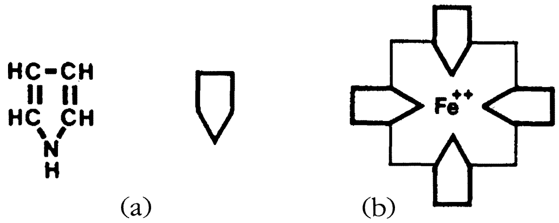
Haemoglobin is not always serving as a respiratory pigment in biological systems, though it always serves as an oxygen carrier. Nevertheless, it is not even the only oxygen carrier—other molecules act as such, like, haemerythrin in some marine worms, chlorocruorin in many molluscs and the haemocyanins in various other molluscs. Thus haemoglobin is common, but not universal as an oxygen carrier among lower animals. Even among vertebrates it is not ubiquitous; the common eel and the ice fish are two well-known animals that lack haemoglobin.

No consideration of haemoglobin can ignore the structurally similar protein, myoglobin, found in vertebrates. This is located in red muscle tissues and functions as an oxygen storage, rather than an oxygen-carrying, molecule. Thus myoglobin occurs in a particularly high concentration in the muscles of sea mammals, such as whales and seals, where it serves as an oxygen store during prolonged periods of underwater diving.

The Structure of Haemoglobin

It may seem commonplace now—and indeed the molecular details of haemoglobin are displayed in every undergraduate biochemistry textbook—but the elucidation of its structure took over 20 years of hard work. However, these labours, which provided much of the foundation of modern biochemistry, yielded considerable honours. Max Perutz and John Kendrew shared the Nobel prize for chemistry in 1962 for their pioneering work in determining the three-dimensional structures of haemoglobin and myoglobin by x-ray crystallography. Perutz and his colleagues wrestled with the enormous task of not just determining the composition of haemoglobin, but the spatial relationship of its every atom, from 1936 until 1959 when the three-dimensional map of horse haemoglobin was completed. Perutz and Kendrew had their research papers detailing the structures of haemoglobin and myoglobin published back-to-back in *Nature* in February 1960.

As already mentioned, etymologically and chemically, haemoglobin is the combination of haem and globin units. Haem gives blood its distinctive colour. To understand something of the structure of haem, it is first necessary to recognise a pyrrole unit (as shown in Fig. 1a chemically and diagrammatically). Four pyrrole units can combine to produce a porphyrin ring and when an iron atom is at the centre of this, the haem molecule is formed (Fig. 1b). Haem is known as the prosthetic group (that is, a non-protein molecule that binds tightly giving biological activity to a protein) of haemoglobin; but it is not unique to haemoglobin and is to be found in many enzymic and other non-enzymic systems. Haem is thus a very stable coordination compound of inorganic iron and organic porphyrin—there are fifteen possible ways that this structure could be arranged, but only one isomer, protoporphyrin IX, occurs in biological systems. Porphyrins are widespread in the biosphere—haemocyanins, already mentioned, contain copper and the pigment of green plants, chlorophyll, contains magnesium instead of the iron of haem.



(a) (b)

Fig. 1. The pyrrole unit and haem molecule

The other component of haemoglobin is globin, a series of 146 or so amino acid residues (depending on the type and source of the haemoglobin) joined together to form a polypeptide (that is, a short protein) chain. There are approximately 20 amino acids that commonly occur in polypeptides and this leads to some interesting mathematics. How many possible ways are there of arranging 20 different amino acids to produce a chain 146 residues long? The answer is inconceivably great; so great that it has been termed the 'haemoglobin number.' In fact it amounts to 20 times itself 146 times. Bearing in mind that a million is a 1 followed by a mere 6 zeros, the 'haemoglobin number' is approximately 1 followed by 190 zeros! So this astronomically huge figure represents the odds of a globin polypeptide chain coming about by chance. Even convinced evolutionists admit that such an event happening spontaneously (in a relatively simple molecule like globin) is 'nowhere near capable of generating the amount of order in living things.' (Dawkins, 1986).

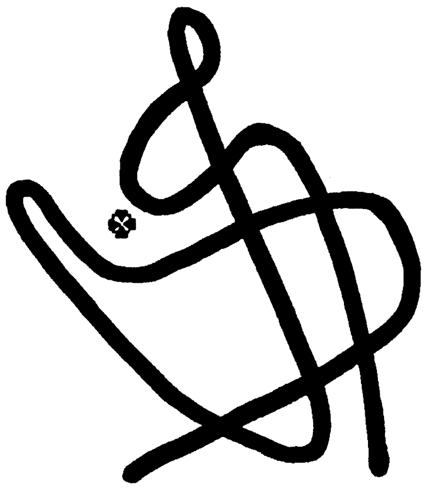


Fig. 2. The haem-globin monomeric unit

A simple haem-globin unit, (a monomer) is diagrammatically represented in Fig. 2—something like 96% of the molecule is globin with the relatively tiny haem tucked away within the twists and turns of the polypeptide chain. Most naturally-occurring haemoglobins exist as aggregates of these haemoglobin monomeric units. Frequently four monomers form a functional unit (a tetramer), and since each monomeric unit contains a haem group, there are four binding sites for oxygen in each haemoglobin unit. The globin moiety comprises a pair of each of two kinds of polypeptide chains to produce the haemoglobin tetramer. These chains are called α and β, so that in most men and women the predominant haemoglobin (haemoglobin A) chain formula is $\alpha_2\beta_2$. Haemoglobin A_2 is a minor component (about 2%) of total haemoglobin in adults—it has a subunit structure of $\alpha_2\delta_2$. Furthermore, the unborn child has distinct haemoglobins—$\alpha_2\varepsilon_2$ during early life *in utero*, followed by $\alpha_2\gamma_2$, which has a higher affinity for oxygen than even haemoglobin A, later on and during early neonatal life. So the forms and structures of our haemoglobins actually change as we develop.

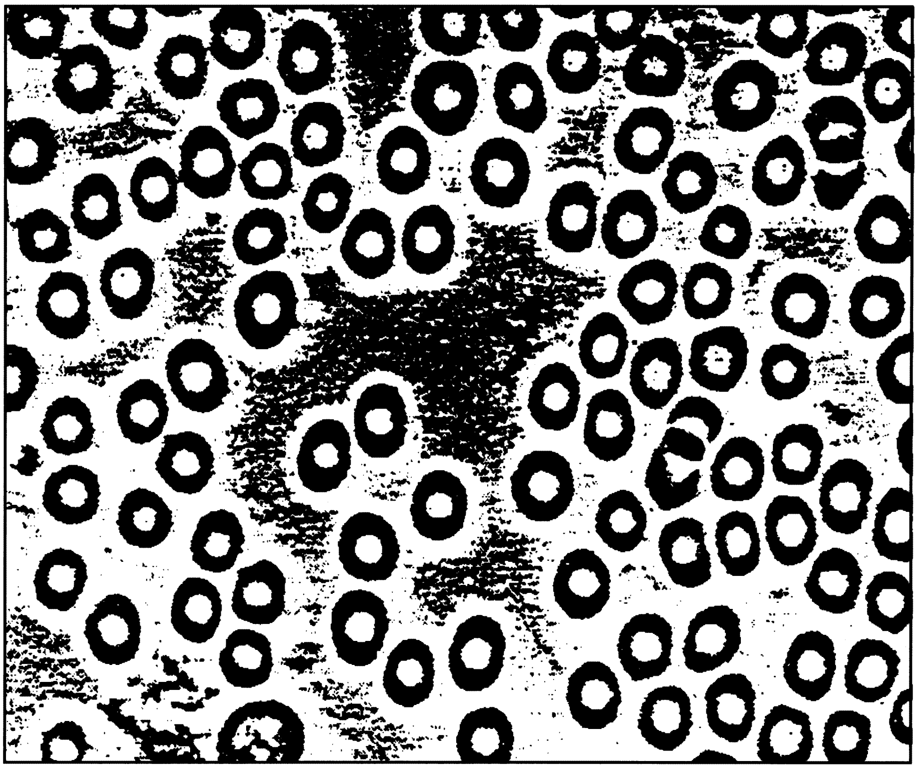
Functional Aspects of Haemoglobin

Every living animal requires a supply of oxygen for respiration, that is, the process that oxidises dietary nutrients with the subsequent production of energy; energy that is essential for all organisms to maintain themselves and to grow and to reproduce and to work and so on. This supply of oxygen is obtained from the animal's surroundings, either from the air or from water.

It is this carrying and supplying of oxygen that is the primary function of haemoglobin. The presence of haemoglobin increases the oxygen-carrying capacity of blood by a factor of 50. This function is based on the ability of haemoglobin to combine with oxygen when the concentration of the latter is high and to release it when the oxygen concentration is low. It is the iron atom, in the ferrous state, held in precisely the correct spatial orientations with respect to the nitrogen atoms in the haem nucleus, that binds the oxygen. In deoxyhaemoglobin, the iron atom is about 0.06 nanometres (that is, a minuscule 6×10^{-11} metres) out of the haem plane. On oxygenation, the iron atom moves into the plane of the porphyrin ring so that it can form a strong bond with the oxygen.

As someone has said, 'haemoglobin will flex its broad shoulders and bend its knees to pick up oxygen.' The globin moiety is essential too because it allows oxygen to bind reversibly. This allows it to function in the role we know best—the binding with oxygen in the lungs, its transport and subsequent release in tissues where the oxygen concentration is low. Of course, it also has that other vital role of transporting carbon dioxide back to the lungs, to be excreted in the air we breathe out.

It may be stating the obvious, but most biological processes are far more complex than generally explained in standard textbooks. The functions of haemoglobin are no exception. Though this is not the place for bewildering detail, haemoglobin is a marvellous example of how simple communication within a molecule can occur and how a molecule can deal with information from its immediate surroundings. In fact, not only oxygen, but also hydrogen ions, carbon dioxide and a phosphate-containing compound, called 2,3-diphosphoglycerate, all bind to haemoglobin. Binding takes place at distinct sites on the haemoglobin molecule and when any such binding does occur, this is communicated to other parts of the molecule by very small changes in their three-dimensional structure. This property of haemoglobin is termed an allosteric interaction and depends upon it possessing more than one polypeptide chain. What it also means is that the monomeric myoglobin and the tetrameric haemoglobin are mechanistically quite different, because only the latter is able to receive and react to information from its environment in this rather amazing way.

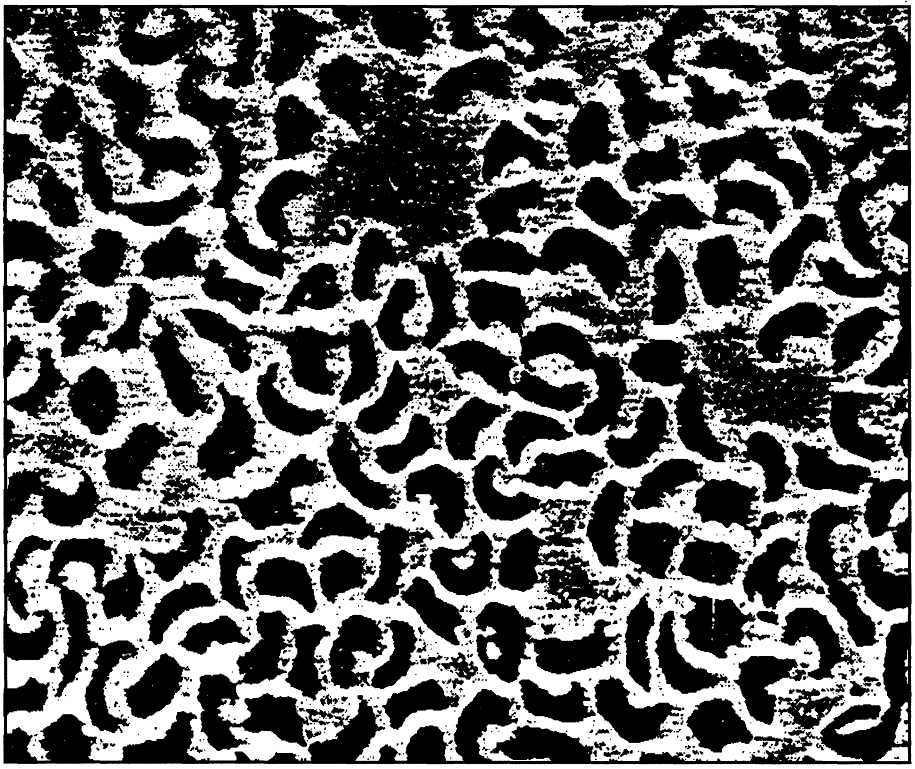


Normal red blood cells (photomicrograph)

Haemoglobin and Genetic Diseases

There are more than four hundred reported genetic variants of the haemoglobin molecule among human beings (Livingstone, 1985). Most of these 'abnormal' haemoglobins are of no consequence to their carriers, but some are, like those causing the thalassaemias. Another such genetic disease, sickle cell anaemia, is of particular interest in coming to a greater understanding of haemoglobin.

At the turn of this century, James Herrick, a doctor in Chicago, described the red blood cells of an ailing college student as 'sickle-shaped and crescent-shaped.' The disease thus became known as sickle cell anaemia. This often fatal disease is relatively common (about four per thousand) among black people. Sufferers are severely anaemic and some of their red blood cells take on this distinct sickle-shape. The anaemia is a consequence of the presence of abnormal haemoglobin S, in which the globin moiety consists of two normal α chains, but two mutant β chains. The result is aberrant red blood cells which are more fragile and thus have a much reduced life compared with the 'normal' 120 days. The actual cause of this genetically transmitted disease is a tiny change in one of the genes of the patient. An adenine base occurs instead of a thymine in the seventeenth nucleotide of the β globin gene somewhere on the long arm of each fourth chromosome. This results in the amino acid in position six of the β globin polypeptide chain being a valine residue instead of a



Sickled red blood cells (photomicrograph)

glutamic acid. The non-polar side chain of this valine drastically reduces the solubility of the deoxyhaemoglobin S, which in turn forms fibrous precipitates that deform the red blood cell into a sickle-shape, instead of the usual 'Pontefract cake' shape.

Consider how fragile human life is. Just one small and simple mutation in just one gene can have the effect of causing such dire clinical consequences. Consider the frailty of human life and the wonderful regulatory checks and balances of genes and proteins and the myriad of metabolites, plus the processes of synthesis and degradation that cause our life to commence, let alone uphold it day by day. But the fascination of this particular haemoglobin-related disease does not end here—there is yet more to understand.

It has long intrigued epidemiologists that the sickle cell anaemia gene (with an incidence as high as 40% in parts of Africa) is so widespread, even though it is potentially fatal. Researchers have noted the similar geographical distribution of sickle cell anaemia and malaria. The protozoal parasite of malaria spends much of its life cycle within the red blood cell and it is now generally accepted that the inability of red blood cells with 'sickle' haemoglobin (haemoglobin S) to support the growth of the malarial protozoa actually confers an advantage to the human carrier. To suffer from sickle cell anaemia, a person must be homozygous for the mutant gene of the β globin chain, this means that abnormal genetic contributions have come from both parents. People who are heterozygotes—bearing dissimilar alternative genetical factors—produce a mixture of normal haemoglobin and haemoglobin S; the heterozygous condition is known as sickle cell trait and is generally not harmful. About 10% of black people are heterozygous for the sickle gene. This high incidence of a gene, that is harmful in homozygotes, is apparently due to the fact that it is beneficial in heterozygotes—a state known as balanced polymorphism. People with sickle cell trait are protected against the most lethal forms of malaria.

This concept, that a disease can occur because of a change, or mutation, in just one amino acid in a polypeptide chain, had its origins in the studies of sickle cell anaemia and was thus another 'first' for haemoglobin. Such mutations are commonly considered to be the raw materials of evolution. However, sickle cell anaemia has shown that a mutation can be simultaneously beneficial and harmful. So what do evolutionary scientists make of this? According to Zuckerkandl and Pauling (1965), 'Subjectively, to evolve must most often have amounted to suffering from a disease. And these diseases were of course molecular. The appearance of the concept of good and evil, interpreted by man as his painful expulsion from Paradise, was probably a molecular disease that turned out to be evolution.' What an amazing statement—if nothing else, very high marks must be given for philosophical creativity!

Haemoglobin and Evolutionary Theory

According to some sources, myoglobin and haemoglobin diverged about 800 million years ago. Furthermore, the constancy of the evolutionary rate is apparently readily observed in haemoglobin. According to those same sources, amino acid substitutions in the α globin chain of mammals, consisting of 141 amino acids, occur roughly at the rate of one substitution per 7 million years (Li, 1983).

The α chain of monomeric haemoglobin does indeed comprise 141 amino acids and the β chain, 146 and that of myoglobin, 153 residues. These molecules are very, very similar in their three-dimensional configuration. This observation has prompted chemical palaeontologists to conclude that they all have a common ancestry—that is, they have evolved from the same molecule. Is this true, or even plausible? Certainly it is beyond cavil that they look alike. Yet that similarity occurs despite considerable differences in their composition. Comparing all three polypeptide chains, only 24 out of 141 residues are common. In addition, only 64 of the amino acid residues along each α and β chain are the same; the other 77 are different. Yet Stryer (1975) has little hesitation in expressing an evolutionary link by stating that, 'The intricate folding of the polypeptide chain first evident in myoglobin is nature's fundamental design for an oxygen carrier; it places the haem in an environment that enables it to carry oxygen reversibly.'

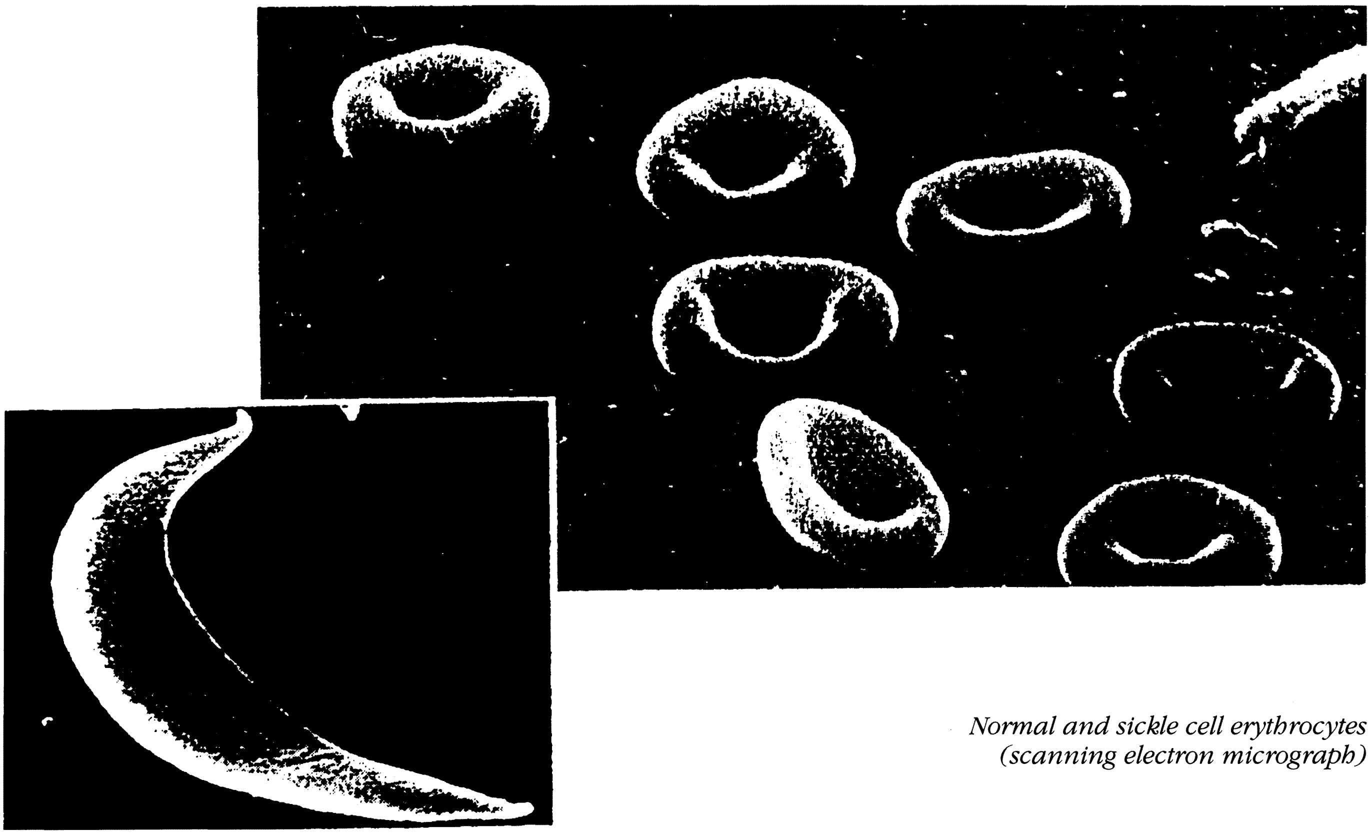
If the α and β chains were once similar, they are for certain now quite different. So why do most scientists believe they were once similar? One typical reply (with my italics) has been given by Zuckerkandl (1965); 'The answer is that it *seems most improbable* that two different and unrelated polypeptide chains *could evolve* in such a way as to have the same function, same conformation and a substantial number of identical amino acid residues at corresponding molecular sites.'

Firstly, Zuckerkandl begs the question, by assuming that evolution is undoubtedly the driving force. Secondly, Zuckerkandl does say, 'it *seems most improbable.*' This lack of assurance is noteworthy. Indeed, in the same article Zuckerkandl also states that using chemical palaeogenetics, 'It *may be possible* to make *informed guesses.....*' Such expressions of uncertainty in the scientific community are rare, even in these speculative areas; they should be noted and welcomed. But to return to the issue. Why is it not considered reasonable to maintain that both α and β chains were created? Cannot the fact that they have similarities point to a common Creator, and the fact that they have differences, point to His creative diversity? This is a rational, discussible position to hold. In these matters we need not shrink into a defensive posture with those who, often unthinkingly, disagree with us.

Is an impasse such as this any more than a conflicting interpretation of the same basic information? Certainly the platform sign at Paddington Station that states 'Dogs must be carried' can convey two messages—one that erroneously can send grown men scurrying in search of mongrels! Yet how straightforward such confusions can become when someone explains them and helps unknot our muddled thinking.

The Lessons of Haemoglobin

Firstly, we can learn to appreciate that we live in a wonderful creation. A sense of awe should be ours as we look, either out to the stars or, into the molecules. We can begin to understand how we are 'fearfully and wonderfully made' (Psalm 139:14); in fact not just us, but all that is around us. Our little lives are so fragile, indeed the whole biosphere is delicately balanced; some would say precariously so, while others would say, wonderfully so. The creation is truly majestic. Christians acknowledge that all of it speaks of Him. It is so vast and so complex. What do we understand of it? Very, very, very little. Yet in the light of what we do know, it seems almost a defeatist attitude to admit, as some Christians do, that, 'evolutionary change ... forms much the simplest explanation' of it all. Since when has simple necessarily equalled true?



Normal and sickle cell erythrocytes (scanning electron micrograph)

Secondly, we should acknowledge the unity within the biosphere—consider the widespread distribution, structure and function of haemoglobin. But so what? This striking similarity of molecular structure (homology) and function does not clinch the argument that human beings came from *amoeba* via the sperm whale or whatever. Would we expect anything other than a biologically unifying pattern from a Creator? Nowhere in the created order do we disparage such relatedness. Now of course, creatively-minded scientists can draw phylogenetic trees—but a line on a piece of paper is proof of what? One species evolving into another? On the other hand, molecular and functional dissimilarities cannot be ignored—otherwise the created order would be nothing other than identical. This range of differences, in haemoglobins for example, has been highlighted recently by Perutz (1990). He concluded, 'This illustrates once again the astounding inventiveness of nature even on the molecular scale.' While some may be dismayed at attributing such a function to so-called 'nature,' the gist of the statement is readily comprehensible.

Thirdly, we must be sure that we are scrupulously honest and truthful in all we communicate. Do we know the facts? Are they indeed, facts? Are the arguments we use proper? Do we conveniently ignore any information? And anyway, why are we engaged in such arguments? What can we admit? Are we, for example, happy with the evidence for gradation in the complexity within the biosphere, yet unconvinced that this suggests any mechanism sufficient to allow one species to evolve into another? Are we clear that genetic mutations, as in mutant haemoglobin molecules, do occur? And are we sure that such mutations produce nothing other than haemoglobins, biochemically and functionally? We must own up to what is evident; we must never put up the scientific shutters. Of all men, why should we fear the truth?

Fourthly, we should understand something of the modern scientific enterprise—in many ways it has been marvellous and dignified and honest, but it has been conducted by mere men (and women) and all such can be selfish, self-seeking and self-centred; solipsism reigns in science too. And men can be wrong. It is a sad observation that there is little apparent concern in the scientific community when some ideas, that can neither be falsified nor verified, (that is, they cannot be subjected to proper scientific assessment) are promoted; such ideas are simply non-scientific.

Fifthly and finally, we should learn to feel, and handle, the tension—the tension of living in a materialistic world among men who believe that all biological life can be reduced to mere chemistry and physics. We must come to terms with the fact that most of our neighbours would believe anything rather than include the transcendent in their schemes of thinking. In addition, we should understand that all men carry around their own sets of presuppositions. We maintain that God spoke and it was—that is a momentous presupposition! We believe that we were created by a personal Creator, that we are made in His image. The men and women of this world think that it all came about as the product of chance and time and that they are going nowhere in particular. It is our responsibility to challenge such thinking. We can (and must) engage in winsome and rational argument for these are areas of concern to modern man: Who am I? Where am I going? Is there any purpose? Now that's a long, long way from considering the design and function of the haemoglobin molecule, but even that might be a starting-point. Experts in these many areas of science we may never be, but every Christian has a most profound and unparalleled understanding of himself and the world. We all ought to be able to communicate something of this over a cup of coffee shared with our neighbour.

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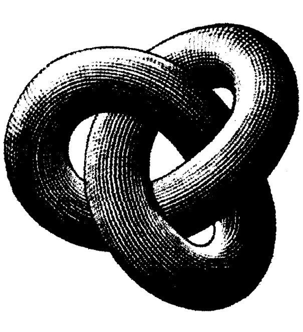

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